Economic Geology of the
Darwin Quadrangle
Inyo County, California

California Division of Mines
Special Report 51

COVER—Darwin surface plant, Darwin Mines. Maturango Peak, highest in the Argus Range, is in the background.
Photo by Mary R. Hill, 1957.

STATE OF CALIFORNIA
GOODWIN J. KNIGHT, Governor
DEPARTMENT OF NATURAL RESOURCES
DeWITT NELSON, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
GORDON B. OAKESHOTT, Chief

N FRANCISCO | SPECIAL REPORT 51 | OCTOBER 1958

ECONOMIC GEOLOGY OF THE DARWIN QUADRANGLE INYO COUNTY, CALIFORNIA

By WAYNE E. HALL and E. M. MACKEVETT

With a Section on the
DARWIN SILVER-LEAD DISTRICT
By W. E. Hall, E. M. Mackevett, and D. L. Davis

and on the
TUNGSTEN DEPOSITS
By W. E. Hall, E. M. Mackevett, and D. M. Lemmon

Prepared in Cooperation with the
CALIFORNIA STATE DIVISION OF MINES

Price $2.50

ECONOMIC GEOLOGY OF THE DARWIN QUADRANGLE, INYO COUNTY, CALIFORNIA †

By Wayne E. Hall * and E. M. Mackevett *

OUTLINE OF REPORT

Illustrations

ublication authorized by the Director, U. S. Geological Survey.
eologist, U. S. Geological Survey.

ABSTRACT

The Darwin quadrangle comprises 225 square miles in [the] west-central part of Inyo County and includes parts of the [Inyo] Mountains, Coso Range, Argus Range, and Darwin Hills. [The] dollar value of the mine production through 1951 is estimate[d at] $37,500,000. The principal commodities are lead, silver, [zinc,] steatite-talc, tungsten, and small amounts of antimony and [gold.]
The Paleozic rocks range in age from Early Ordovicia[n to] Permian in an essentially conformable sequence more than 1[...] feet thick. Silurian and Ordovician rocks are predominantly [dolo-]mite; Devonian rocks are limestone, dolomite, shale, and quart[zite;] and Mississipian and younger Paleozic rocks are mainly limes[tone.] The Paleozoic strata are intruded by the batholith of the [Coso] Range in the southwestern part of the quadrangle, the bath[olith] of Hunter Mountain in the northeastern part, and by many s[mall] plutons. Most of the northern half of the quadrangle is covere[d by] olivine basalt flows and andesite of late Cenozoic age.
Structurally the area is on the west limb of a major [syn-]clinorium where the Paleozoic strata strike predominantly n[orth] to N. 30° W. and dip gently to the west. Within 2 or 3 mil[es of] major intrusive bodies the structure is much more complex; [the] beds are tightly folded and faulted, and much of the beddi[ng is] overturned. Inverted anticlines and synclines are common.
The mineral deposits are concentrated around the margi[n of] the batholith in the Coso Range. The Darwin silver-lead dis[trict] is in the Darwin Hills on the east side of the Coso bath[olith.] Lead-silver-zinc deposits are mainly on the western side of [the] Darwin Hills and tungsten deposits are on the eastern side. [Talc] deposits are in the Talc City Hills at the north end of the ba[tho-]lith.
Limestone—altered to calc-hornfels and tactite—is the host [rock] for most of the lead-silver-zinc deposits and the tungsten depo[sits;] dolomite and to a lesser extent quartzite are the host rocks fo[r the] talc deposits. Fractures have controlled the deposition of most [ore] bodies.

INTRODUCTION

Purpose and Scope

The present investigation of the Darwin quadra[ngle] is part of a long-range program by the U. S. Geolog[ical] Survey, in cooperation with the California Divisio[n of] Mines, to study the geologic factors relating to the l[ead-]silver-zinc deposits in a belt extending from the I[nyo] Mountains southeastward to the Resting Spring dist[rict] in the Tecopa quadrangle, a distance of about 120 m[iles.] The Cerro Gordo, Ubehebe, Darwin, Modoc, Panam[int,] Resting Springs, and several smaller districts lie wi[thin] this belt. As part of the program C. W. Merriam [and] Ward C. Smith of the U. S. Geological Survey [pre-]viously mapped the New York Butte quadrangle, w[hich] includes the Cerro Gordo district and a report of t[his] investigation is under preparation, and J. F. McAlli[ster] (1955, 1956) mapped the Ubehebe Peak quadrangle.

The Darwin quadrangle, which lies southeast of [the] New York Butte quadrangle and south of the Ube[hebe] Peak quadrangle, was mapped during 1952 and 1[953] and the mineral deposits were studied during 1954. [The] quadrangle contains some of the most important l[ead-]silver-zinc mines in the State, the largest steatite-t[alc] producing area in the State, and significant tung[sten] deposits.

The report is divided into two parts. The first [part] briefly describes the rocks and structure of the Dar[win] quadrangle. The second part is a description of [the] mineral resources, including the deposits in the Dar[win] lead-silver district, the Zinc Hill district, the Lee dist[rict] and the Talc City Hills. Emphasis is given to desc[rip-]tions of the lead-silver-zinc deposits. The talc dep[osits] are described only briefly, as detailed mine descript[ions] have been published recently by Page (1951). The t[...]

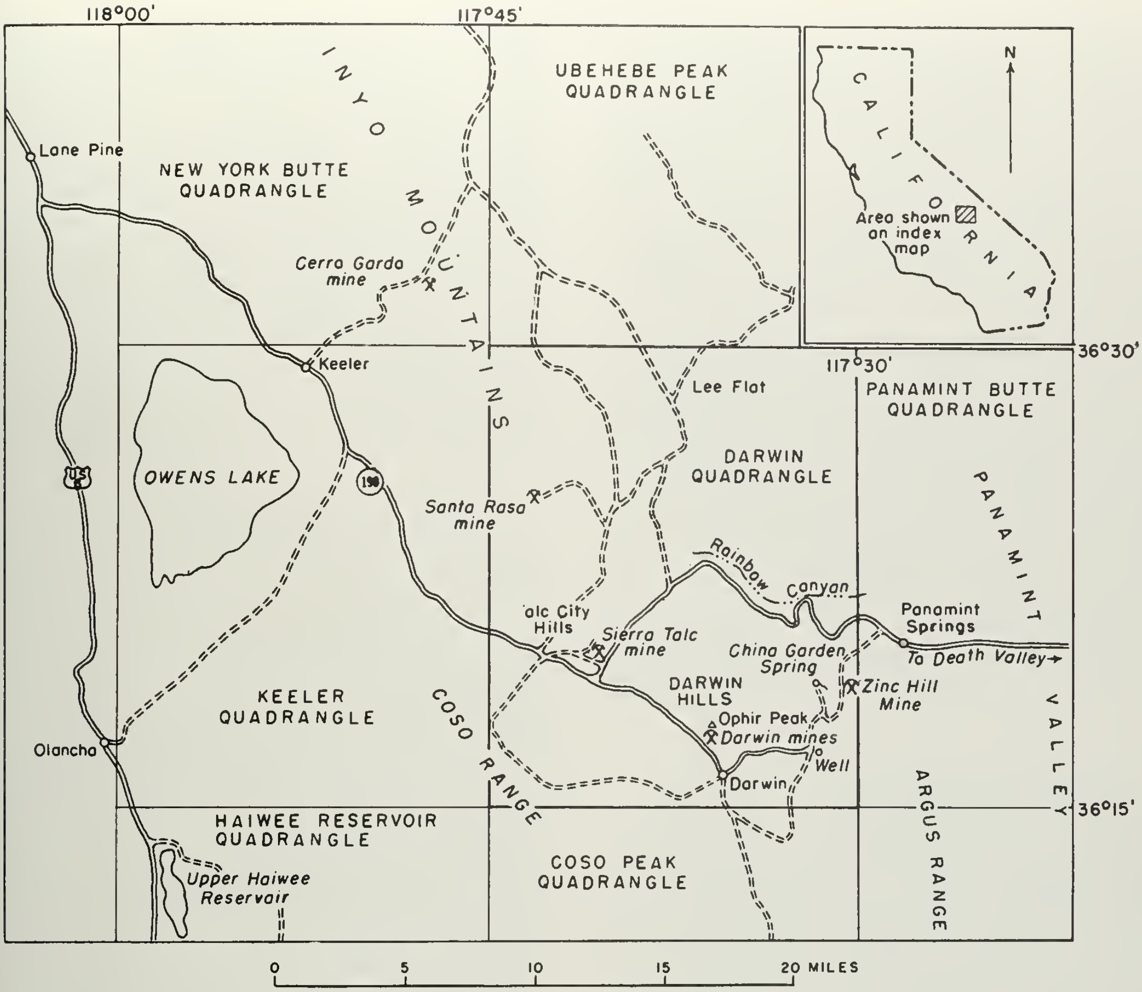


FIGURE 1. Index map of the Darwin quadrangle showing location of principal geographic features.

eposits were mapped in 1941 and 1942 by a U. S. gical Survey party under D. M. Lemmon, and their are published herein.

Location and Accessibility

Darwin quadrangle is in central Inyo County in utheastern part of California 35 miles southeast of hitney and 40 miles west of Death Valley between ians 117°30′ and 117°45′ W. and parallels 36°15′ 6°30′ N. (Fig. 1). The southern end of the Inyo tains, the northeastern flank of the Coso Range, and rthwestern flank of the Argus Range lie within the angle. Darwin, a small mining town of several ed inhabitants, is the only town within the quad-. The Anaconda Company maintains a large min-mp about a mile northwest of Darwin, and a few nces are at some of the mines and springs.

te Highway 190, which connects U. S. Highway 6 Lone Pine with Death Valley, traverses easterly the central part of the quadrangle. Abundant liary roads branch off from the State Highway and le good access. The nearest railroad is 13 miles by northwest of the Darwin quadrangle at Keeler, the ern terminus of Southern Pacific's narrow-gauge ad from Keeler to Laws, Calif. Lone Pine, the prin-supply center, is 26 miles by paved highway north-of the Darwin quadrangle.

Climate and Vegetation

The climate is characterized by scant rainfall, a prevalence of wind, and by a considerable diurnal and annual range in temperature. The closest weather station is 14 miles southwest of the Darwin quadrangle at Haiwee at an altitude of 3,830 feet. The U. S. Weather Bureau's publication *Climatological Data* for 1948 lists the normal annual rainfall at Haiwee as 6.06 inches. The average January temperature is 40.4° F, and the average July temperature is 81.7° F. The extremes in recorded temperature for 1948 are a high of 102° F and a low of 14° F. Except at the lower altitudes near Panamint Valley where the summer temperatures are uncomfortably hot, the figures listed above are probably typical of most of the area in the Darwin quadrangle.

Vegetation is sparse, consisting of scattered creosote bush and some cacti and Joshua trees. An impressive stand of Joshua trees is growing at Lee Flat. Piñon pines and junipers grow in some places at altitudes above 6,000 feet, except where the bedrock is basalt.

Topography and Water Supply

The Darwin quadrangle is in the western part of the Basin and Range physiographic province, in which parallel mountain ranges trending N. 10°-20° W. rise above intermontane plains. Narrow, deeply incised, easterly trending canyons are prominent topographic features in the eastern part of the quadrangle. Altitudes range from 1,960 feet in an unnamed canyon 2 miles north of Rainbow Canyon to 7,731 feet in the Inyo Mountains.

Drainage is into two enclosed basins, the Panamint Valley to the east and Owens Lake to the west. About four-fifths of the quadrangle drains into Panamint Valley, principally through Darwin Wash, Santa Rosa Flat, and Lee Flat. The remaining area in the southwestern part of the quadrangle drains through Lower Centennial Flat into Owens Lake.

Darwin Wash and Darwin Canyon provide the principal water supply in the quadrangle. The drainage from an area of 165 square miles, which includes the Darwin Hills, the west flank of the Argus Range, and the northeast flank of the Coso Range in the Darwin quadrangle and the northern half of the Coso Peak quadrangle, is funneled into Darwin Canyon. Wells and springs in the canyon provide the water supply for the Darwin Mines, the Miller-Warnken tungsten mill in Darwin Canyon, a mill and residence at China Garden Springs, and the motel at Panamint Springs. The town of Darwin receives its water supply through a pipe line from a spring in the Coso Range 8 miles to the southwest. Water is hauled from Darwin or Lone Pine to the Santa Rosa mine and the mines in the Talc City Hills and Santa Rosa Hills

Previous Work and Acknowledgments

Early mining activity near Darwin is described by Raymond (1877, p. 25-30), Burchard (1884, p. 163-164), and in reports of the State Mineralogist (Goodyear, 1888; Aubury, 1902 and 1908). Knopf (1914) wrote on the geology and ore deposits of the Darwin lead-silver district, and Kelley (1937; 1938) mapped the Darwin Hills and made large scale maps of some of the mines. Hopper (1947) mapped about 90 square miles in the southern part of the Darwin quadrangle in his reconnaissance study of a strip from the Sierra Nevada to Death Valley.

Commodity studies carried on by the U. S. Geological Survey during World War II covered some of the mineral deposits. Preliminary reports were made available to the writers on the lead-silver-zinc deposits by C. W. Merriam and L. C. Craig and on the tungsten deposits by D. M. Lemmon and others. B. M. Page (1951) and L. A. Wright studied the talc deposits during World War II and T. E. Gay, Jr. and L. A. Wright (1954) mapped the geology of the Talc City area.

L. K. Wilson (1943), resident geologist for the Pacific Tungsten Company, described the tungsten deposits on the east side of the Darwin Hills. D. L. Davis and E. C. Peterson (1948) of The Anaconda Company described the geology and ore deposits of the Darwin Mines. A report on the Santa Rosa mine is a product of the present investigation (MacKevett, 1953).

The writers wish to express their gratitude to the mining people in the area for their wholehearted cooperation. The Anaconda Company furnished maps of many of the mines owned by them in the Darwin district and extended many other courtesies to the writers. Especial thanks are due D. L. Davis, John Eastlick, M. B. Kildale, and F. E. Tong. E. H. Snyder of Combined Metals Reduction Company furnished production data and a map of the upper workings of the Zinc Hill m... Many other individuals supplied production data, ... are credited under individual mine descriptions.

J. F. McAllister and C. W. Merriam of the U... Geological Survey were of great help with stratigra... and structural problems. E. H. Bailey, district super... ing geologist for the U. S. Geological Survey, provi... valuable suggestions during the preparation of the ... port. Field work was benefited by discussions with M... Billings of Harvard University and C. E. Stearns ... Tufts University. Many geologists provided capable f... assistance for periods ranging from 2 weeks to 3 mon... These include L. A. Brubaker, Santi das Gupta, J... Hernandez, Victor Mejia, E. H. Pampeyan, D. L. P..., H. G. Stephens, and D. H. Thamer. The cartography ... done under the direction of Esther T. McDermott.

GENERAL GEOLOGY

Rocks in the Darwin quadrangle include sediment... rocks of Paleozoic age, plutonic and hypabyssal ro... of late Mesozoic age, and volcanic rocks and sedime... of Cenozoic age. The stratigraphic sequence is sum... rized in table 1. Paleozoic rocks range in age from Ea... Ordovician to Permian in a sequence approximat... 14,200 feet thick. Formational contacts are conforma... except for local unconformities in the Pennsylvan... and Permian series. Pre-Mississippian rocks are mai... dolomite; Mississippian and younger rocks are pred... inantly limestone. Similar Paleozoic sections have b... described in adjacent areas by McAllister (1952, 19... and Merriam (1954).

The Paleozoic rocks are intruded by the batholith ... the Coso Range in the southwestern part of the qu... rangle, the batholith of Hunter Mountain in the nor... eastern part, and by several small plutons in the Darw... Hills and Argus Range. Volcanic rocks and sediments ... late Cenozoic age unconformably overlie the Paleoz... and Mesozoic rocks.

The distribution of the rocks and the location of ... ore deposits are shown in plate 1. The purpose of ... map is to show the distribution of the mineral depos... with respect to lithology and nearness to igneous c... tacts. The geology has been simplified and the faults ... not shown. The distribution of the mineral depos... about the margin of the batholith of the Coso Range, ... restriction of talc deposits to a dolomite and quartz... host rock of Devonian or older age, and the concent... tion of lead-silver-zinc and tungsten deposits in li... stone of late Paleozoic age are the principal geolo... features shown on the map.

Sedimentary Rocks of Paleozoic Age

Pogonip Group

The Pogonip group of Early and Middle Ordovic... age is the oldest rock sequence exposed in the quadran... It crops out in isolated or fault-bounded segments alo... the southwest side of the Talc City Hills and at the e... end of the hills west of the West Virginia claim (pl. ... Although the base of the sequence is unexposed, m... of the Pogonip group is exposed west of the West V... ginia claim by a section 1,570 feet thick.

The group consists predominantly of light-gr... medium- to thick-bedded dolomite, but includes li... stone, shaly limestone, and siliceous limestone in ...

able 1. Stratigraphic section of the Darwin quadrangle.

	Age		Lithologic unit	Thickness (feet)
QUATERNARY	Recent		Alluvium, including fanglomerate, playa deposits, and minor lake beds	
QUATERNARY	Pleistocene		Olivine basalt flows, fanglomerate, and Darwin Wash lake beds of Hopper, 1947	0–600
TERTIARY(?)	Pleistocene or Pliocene		Coso formation of Schultz, 1937	
TERTIARY(?)	Pliocene(?)		Andesite, basaltic pyroclastics, basalt flows, pumice	910+
	Cretaceous(?)		Hypabyssal rocks—andesite porphyry and alaskite dikes	
	Cretaceous		Batholith of Hunter Mountain, batholith of the Coso Range, and related intrusive rocks—mainly quartz monzonite but includes granodiorite, syenodiorite, gabbro, leucogranite, and aplite	
	Permian	Owens Valley formation	Limestone-conglomerate member—includes limestone conglomerate, siltstone, and calcarenite	180+
		Owens Valley formation	Shale member—brick-red and yellowish-brown shale; subordinate siltstone and limestone	200
		Owens Valley formation	Lower limestone member—mainly fine-grained calcarenite; some thick limestone lenses, shale, and siltstone	2,800
	Permian and Pennsylvanian	Keeler Canyon formation	Upper member—calcilutite and fine-grained calcarenite with lesser shale and limestone-pebble conglomerate	1,700
		Keeler Canyon formation	Lower member—thin-bedded limestone with intercalated limestone-pebble conglomerate	2,300±
	Pennsylvanian(?)		Rest Spring shale—dark-brown fissile shale, minor siltstone. The Rest Spring shale is present only as fault slivers in the northwest part of the quadrangle. It is the stratigraphic equivalent of the upper part of the Lee Flat limestone	0–50+
	Pennsylvanian(?) and Mississippian		Lee Flat limestone—thin-bedded medium-gray limestone; equivalent to the upper part of Perdido formation and to the Rest Spring shale	520+
	Mississippian		Perdido formation—limestone and bedded chert	330
			Tin Mountain limestone—fossiliferous thin- to thick-bedded limestone with chert lenses and nodules	430
	Devonian		Lost Burro formation—coarse-grained white and light-gray marble; dolomite and limestone in lower part of formation; minor quartzite and shale	1,770+
	Devonian and Silurian		Hidden Valley dolomite—light-gray, massive dolomite	1,000±
	Ordovician		Ely Springs dolomite—dark-gray dolomite with chert beds and lenses; some light-gray dolomite	920±
			Eureka quartzite—light-gray to white vitreous orthoquartzite	440
			Pogonip group—light- and medium-gray thick-bedded dolomite; some thinner-bedded dolomite and limestone	1,570+

dle and upper parts. The siliceous limestone beds ther dark brown and are a distinctive horizon marker. ss-bedding is common near the top of the sequence. widespread fossiliferous horizon is in the Pogonip ıp about 250 feet below its contact with the Eureka rtzite. The fossils, which include *Receptaculites*, ndant large gastropods *Palliseria longwelli* and *Mactes* Sp?, and probable algal remains, are indicative Chazy age (Middle Ordovician).

Eureka Quartzite

Eureka quartzite is abundantly exposed in the Talc City Hills, where it forms distinctive, glistening white, outcrops. It is on both flanks of the overturned syncline at the northwest end of the Talc City Hills 1,600 feet northeast of the White Swan mine and at the Hard Scramble talc prospect. Isolated patches of the Eureka crop out between the Alliance talc mine and the Cactus Owen prospect. Most contacts of the Eureka are faults, and isolated blocks of Eureka quartzite as much as several hundred feet long are common in fault zones in the Pogonip group and Ely Springs dolomite.

The Eureka quartzite is 440 feet thick in an unfaulted section on the ridge 2,000 feet N. 30° E. of the northernmost workings of the White Swan talc mine (pl. 2). The formation consists almost entirely of white vitreous quartzite, but brown-weathered, in part platy quartzite crops out locally above the basal contact. Individual quartz grains are mostly of coarse silt size. Cross-bedding is common in the basal part of the formation.

The age of the Eureka is Middle Ordovician. It lies above Middle Ordovician fossils near the top of the Pogonip group and below the fossiliferous Ely Springs dolomite of Late Ordovician age.

Ely Springs Dolomite

Exposures of Ely Springs dolomite are confined to the Talc City Hills. The formation crops out mainly in the northwestern part of the hills on both flanks of an overturned syncline (pl. 2). Other exposures are at the Trinity talc mine, in two bands extending west from the Alliance talc mine, and on the hill 1 mile east of the Viking talc mine. The contact of the Ely Springs dolomite with the underlying Eureka quartzite is marked by abrupt lithologic and color differences and forms the most conspicuous formational boundary in the Paleozoic section. The sharp change from the white vitreous quartzite of the Eureka to the dark-gray, thick-bedded dolomite of the Ely Springs may be readily distinguished even at a distance of a mile.

A complete section of Ely Springs dolomite on the ridge 3,500 feet N. 6° E. of the northernmost workings of the White Swan mine is 920 feet thick. The lower part of the formation consists of dark-gray, thick-bedded dolomite with irregular lenses and nodules of chert. It grades upward through medium-gray to massive, light-gray dolomite. A bed of dark-gray dolomite, 50 feet thick, is present at most places at the top of the formation.

The formation has been dated as Late Ordovician in age by C. W. Merriam of the U. S. Geological Survey based on fossils collected from the lower part of the Ely Springs on the ridge southeast of the Hard Scramble prospect.

Hidden Valley Dolomite

Hidden Valley dolomite crops out for $1\frac{1}{4}$ miles along the crest of the ridge 1,400 feet west of the Hard Scramble prospect, and other smaller outcrops are present north of the Alliance talc mine, 700 feet south of the Talc City mine, and 300 feet north of the Trinity talc mine. The formation consists entirely of massive, buff to light-gray dolomite. The dolomite is recrystallized, and very little bedding is preserved. The entire section of the Hidden Valley is not exposed at any one locality within the quadrangle. Approximately 1,000 feet of Hidden Valley dolomite is exposed along the ridge between the White Swan talc mine and the Hard Scramble prospect, although the upper part of the formation is eroded.

Only meager, indeterminate fossil remains were found in the Hidden Valley dolomite in the Talc City Hills. McAllister (1952, p. 16) dated the Hidden Valley dolomite as Silurian and Early Devonian in age in the Quartz Spring area.

Lost Burro Formation

The Lost Burro formation crops out in the Santa Rosa Hills underlying the hill at the Silver Reid prospect, in the Talc City Hills at the Cactus Owen, Homestake, and Talc City mines, and on the west flank of the Darwin Hills. No complete section of the Lost Burro is exposed in the quadrangle, but the thickness is probably greater than 1,700 feet and a composite section may be as thick as 2,400 feet. The accuracy of this estimate is somewhat impaired by minor faulting and folding. The formation consists of light-gray dolomite, quartzite, sandy limestone, shale, and chert in the lower part and white to light-gray marble with local thin quartzite beds in the upper part. The lower part of the formation is exposed at the Talc City mine. It consists of 65 feet of interbedded brown-weathering quartzite, sandy limestone, and chert and is correlated with the Lippincott member (McAllister, 1955, p. 12). This lower part is overlain by about 600 feet of light-gray mottled dolomite that, in turn, is overlain by light-gray limestone and shale. The upper part of the formation is exposed in the Santa Rosa Hills at the Silver Reid prospect, and it consists of white to light-gray marble with minor thin quartzite beds. The marble is finely banded with alternating white and medium-gray layers. Some medium-gray limestone beds within the white marble contain abundant *Cladopora* and *Stromatopora*. The age of the Lost Burro is Devonian.

Tin Mountain Limestone

Tin Mountain limestone crops out for 4 miles along the crest of the Santa Rosa Hills, and smaller exposures are at the Lee mine and locally along the west flank of the Darwin Hills. The formation is 435 feet thick at the south end of the Santa Rosa Hills. The dominant rock type is medium- to dark-gray, fine-grained limestone in beds ½ foot to 12 feet thick. Chert lenses and nodules and crinoidal debris are common throughout the Tin Mountain limestone. At the south end of the Santa Rosa Hills the Tin Mountain limestone is bleached and in part recrystallized to marble, so that it resembles marble of the Lost Burro formation. Elsewhere a sharp color contrast distinguishes the dark limestone of the Tin Mountain from the underlying coarse-grained white marble of the Lost Burro formation.

The Tin Mountain limestone is the most fossiliferous formation in the quadrangle and contains numerous corals, brachiopods, bryozoans, and crinoidal stems. Several collections of fossils from the Tin Mountain of the Santa Rosa Hills were examined by Helen Duncan and by Mackenzie Gordon, Jr., of the U. S. Geological Survey, who summarized his findings of the brachiop[o]
as follows:

"The three collections appear to represent approximately [the] same faunal assemblage. The small narrow *Spirifer* sp. A, w[ith] rather long dental plates and about 5 ribs on each side of a narr[ow] sinus in the pedicle valve, occurs both in collection F-1 and [...] along with poorly preserved horn corals that have a general lo[w] Mississippian aspect, according to Miss Duncan.

Cyrtina and *Leptaena* are genera that range through Silur[ian] and Devonian rocks and into the lower Mississippian. In [the] western United States *Leptaena analaga* (Phillips) is typical [of] the rocks of Madison age and is not definitely known to ra[nge] higher. In the mid-continent this species and several cyrtinas [are] known in rocks of Kinderhook and Osage age and are not kno[wn] to range as high as uppermost Osage. *Rhipidomella oweni* (Ha[ll]) with which several partly crushed silicified specimens are h[ere] compared is a widespread lower Osage form. The presence of [a] large productid, though too poorly preserved to identify even as [to] genus, precludes a Devonian age for the assemblage. The rest [of] the specimens are not well preserved or entire enough to add a[ny] evidence to that discussed above.

In summary, the fossils can be said to represent an ea[rly] Mississippian (Madison) fauna. In terms of mid-continent st[ra]tigraphy they are believed to be not younger than Osage in [age] and may be Kinderhook in age."

Perdido Formation

The Perdido formation is present mainly in the San[ta] Rosa Hills conformably overlying Tin Mountain lim[e]stone and locally at the south end of the Talc City Hi[lls] and on the western flank of the Darwin Hills. The form[a]tion is approximately 325 feet thick in the Santa Ro[sa] Hills. It consists predominantly of limestone, silty lim[e]stone, and chert. Thin-bedded, medium-gray limesto[ne] with thin layers of bedded chert are characteristic of t[he] lower part of the formation. Chert is much more abu[n]dant in the upper part of the formation where it [is] present in beds as much as 60 feet thick at the south e[nd] of the Santa Rosa Hills. The lithology of the lower pa[rt] of the Perdido formation and the upper part of the T[in] Mountain limestone is similar and the contact betwe[en] the two is placed at the base of the lowermost bedd[ed] chert in the Perdido formation.

The Perdido formation is much thinner in the Darw[in] quadrangle than in the Quartz Spring area where M[c]Allister (1952, p. 23) measured a section about 610 fe[et] thick. The Perdido formation in the Darwin quadrang[le] is similar in lithology to the lower part of the Perdi[do] formation in the Quartz Spring area, although the upp[er] clastic part of the Perdido is missing. The age of t[he] formation, according to McAllister (1952, p. 24) [is] Mississippian based on fossils in the Ubehebe Peak qua[d]rangle and the Quartz Spring area.

Lee Flat Limestone

The Lee Flat limestone is named here for exposur[es] near Lee Flat, a Joshua-tree-studded, alluviated ar[ea] east of the Santa Rosa Hills. The type section tren[ds] south from near the top of the prominent hill nine-tenth[s] of a mile S. 36° E. of the main shaft of the Lee min[e]. The formation is exposed for 4½ miles along the nort[h]east side of the Santa Rosa Hills, and it forms the pro[m]inent hill 3,000 feet south of the Lee mine. Smaller ou[t]crops of Lee Flat limestone are in the southern part [of] the Talc City Hills and along the west flank of t[he] Darwin Hills.

The predominant rock type is thin-bedded, mediu[m] to dark-gray limestone. Locally the generally unifor[m] ance of the limestone is broken by thin, sandy ained partings or by thin beds and lenses of chert. ee Flat limestone is at least 520 feet thick at the ocality where it conformably overlies the Perdido ion. The upper part of the limestone is covered by m. The formation is estimated to be more than et thick on the hill 3,000 feet south of the Lee out the top of the formation is covered by basalt uvium, and faulting in the exposed section vitiates imate.

only fossils found in the Lee Flat limestone are fragments; consequently the age of the forma- derived from its stratigraphic position. The for- lies conformably on limestone and chert that are ted with the lower part of the Perdido formation Ubehebe Peak quadrangle, where the lowest beds obably Early Mississippian. (See Helen Duncan *in* ister, 1952, p. 24.) The top beds of the Perdido ion in the Quartz Spring area are of Chester age Mississippian) (McAllister, 1952, p. 24). The Lee mestone occupies the same stratigraphic position ne upper part of the Perdido formation and the pring shale occupy in the Quartz Spring area and be Peak quadrangle (McAllister, 1952, pl. 2). igh there are no fossils to show equivalence of age, ee Flat limestone probably correlates with the part of the Perdido formation of Late Mississip- ge and all of the Rest Spring shale of Pennsyl- (?) age. It then represents a facies change from ic section of siltstone, shale, and minor limestone Ubehebe and Quartz Spring areas to fine-grained one in the Darwin quadrangle.

he Darwin Hills the Lee Flat limestone is overlain Keeler Canyon formation, which ranges in age probable Atoka or Des Moines (Pennsylvanian) to Wolfcamp (Permian). It is probably a time- graphic equivalent of the Chainman shale in the York Butte quadrangle of Late Mississippian age.

oring Shale

Rest Spring shale is present only in fault zones in arwin quadrangle in the northern part of the Dar- ills, in the Santa Rosa Hills, and in the Talc City The formation consists of dark-brown, fissile shale. est Spring shale conformably overlies the Perdido tion in the Ubehebe Peak quadrangle (McAllister, p. 13). The Lee Flat limestone conformably over- ne lower part of the Perdido formation in the n quadrangle and the upper part of the Perdido tion is absent. The Rest Spring shale is probably a graphic equivalent of the upper part of the Lee imestone. McAllister (1952, p. 26) considers the Spring shale to be Pennsylvanian (?) in age.

Canyon Formation

Keeler Canyon formation is defined by Merriam Hall (1957, p. 4) as a thick sequence of limestone ed in Keeler Canyon in the New York Butte quad- e and east of the portal of the Estelle tunnel 2 miles west of Cerro Gordo Peak. The formation crops out Darwin quadrangle in the northern part of the Rosa Hills, the eastern part of the Talc City Hills, the western part of the Darwin Hills. No complete errupted section is present in the quadrangle, but a composite of measured partial sections in the western part of the Santa Rosa Hills indicates an approximate thickness of 4,000 feet.

The Keeler Canyon formation is divided into two members in the Darwin quadrangle. The lower member, which is estimated to be about 2,300 feet thick, consists of thin- to medium-bedded bluish-gray limestone with minor limestone-pebble conglomerate. It underlies the hill west of the Darwin Antimony mine in sec. 2, T. 19 S., R. 40 E. at the north end of the Darwin Hills, and the calc-hornfels that underlies Ophir Mountain and all of the Darwin mine area is a metamorphosed part of the lower member.

The upper member consists of pink shale, bluish-gray silty limestone, and limy siltstone. Crossbedding is common near the top of the upper member, but it was not observed in the lower member. A measured section along the ridge trending east from the Darwin Antimony mine is 1,700 feet thick. The contact between the lower and upper members is gradational, and it is arbitrarily placed below the abundant pink shale and pink silty limestone of the overlying member. Slopes underlain by the upper member have a pinkish hue in contrast to a grayish hue of slopes underlain by the lower member.

The Keeler Canyon formation ranges in age from probable Atoka or Des Moines (Pennsylvanian) to probable late Wolfcamp (Permian) according to L. G. Henbest and R. C. Douglass of the U. S. Geological Survey. Fusulinids are the most abundant fossils, but in many the internal structures are impaired by silicification to such an extent that assured identifications are unobtainable.

A report by Lloyd G. Henbest of the U. S. Geological Survey concerning a collection of fusulinids from near the base of the Keeler Canyon formation in the Santa Rosa Hills 1.58 miles S. 77° W. of the Lee mine is given below.

F-9591 *Pennsylvanian*, Atoka or Des Moines age.
Solenoporoid Algae
Climacammina sp.
Endothyra sp.
Millerella ? sp.
Fusulinella sp. or *Wedekindellina* sp.
Fusulinella sp. or an early form of *Fusulina*.

"Most of the specimens show massive deformation and poor preservation. The fusulinids are identified generically with fair assurance. The age indicated is Atoka or very early Des Moines. The foraminiferal association gives support of very limited value to this age determination. The species of solenoporoid Algae is a fossil of common occurrence in the Rocky Mountain region. In my experience, it is limited to rocks of Atoka and of approximately the first half of Des Moines age. By the fusulinids alone, in this state of preservation, I could not definitely prove that they are not of early Permian age. The assemblage and especially the peculiar solenoporoid all agree in indicating Atoka or early Des Moines age."

Two collections of fusulinids were made at the top of the upper member of the Keeler Canyon formation at the north end of the Darwin Hills northeast of the Darwin Antimony mine. These collections were examined by R. C. Douglass of the U. S. Geological Survey in 1954, and his reports are given below.

F-9748 "At north end of Darwin Hills in sec. 35 (projected), T. 18 S., R. 40 E., at elevation 5,290 feet. Located 3.92 miles N. 73° E. from road junction of State highway 190 and Darwin turn off and 1.20 miles N.

33° W. of VABM 5979. In thinly bedded blue-gray, fine-grained limestone."

Climacammina sp.
Tetrataxis?
Endothyra?
Schwagerina spp.
One aff. *S. compacta* (White)

"Evidence on the age of this sample is inconclusive. The sample is probably of Wolfcamp age, possibly middle to late Wolfcamp."

F-9749 "At north end of Darwin Hills at elevation 5,400 feet. Located in gully 660 feet north of VABM 5979 and 4.39 miles N. 86½° E. of junction of State highway 190 and Darwin turn off. In 3-foot thick limestone bed interbedded in pink fissile shale."

Calcitornellids
Climacammina sp.
Triticites sp.
Schwagerina spp. (possibly 3 species)
One aff. *S. diversiformis* Dunbar & Skinner
Another aff. *S.* linearis Dunbar & Skinner
Pseudoschwagerina sp.
Parafusulina?

"This assemblage contains elements common to the uppermost Wolfcamp and lower Leonard formations. It can probably be correlated with this boundary zone with fair certainty."

Owens Valley Formation

The name Owens Valley formation is defined by Merriam and Hall (1957, p. 7) as a sequence of limestone and shale exposed extensively on the western slope of the Inyo Range; the type locality is in the foothills between Union Wash and the Reward mine, about 9 miles southeast of Independence. The formation is abundantly exposed in the Darwin quadrangle. It underlies Conglomerate Mesa (pl. 1) and the low group of hills at the head of Santa Rosa Flat in the northwestern part of the quadrangle, and it is in the southeastern part of the quadrangle on the east side of the Darwin Hills, in Darwin Canyon, and on the west flank of the Argus Range.

The Owens Valley formation is more than 3,200 feet thick and consists of interbedded calcarenite, silty limestone, pure limestone, siltstone, and shale. For convenience of description, it is divided informally into 3 members. The lower member is about 2,800 feet thick and consists of calcarenite, shaly limestone, lenses of pure limestone, shale, and siltstone and will be referred to as the lower limestone member. Lenses of bluish-gray, pure limestone as much as 40 feet thick and several thousand feet long are characteristic of the lower member, and cross-bedded calcarenite is abundant. A contact between the Keeler Canyon formation and the lower member of the Owens Valley formation is 4,500 feet east of the Darwin antimony mine. A brown-weathering siltstone 450 feet thick is at the base of the formation, and this is overlain by interbedded calcarenite, pure limestone, and shaly limestone. It was not possible to correlate details of lithology in the Keeler Canyon formation and lower member of the Owens Valley formation in the Darwin Hills to those in the group of low hills at the head of Santa Rosa Flat in the northwestern part of the quadrangle. A gradational contact between these two formations in the northwestern part of the quadrangle is 3 miles east of the northwest corner of the quadrangle. The Owens Valley formation to the west contains abundant lenses of pure limestone in calcarenite while the underlying Keeler Canyon to the east contains abundant interbedded pink shale and silty limestone. No siltstone bed similar to the one in the Darwin Hills was [illegible] at the contact, but another siltstone bed 250 feet [illegible] is in the upper member of the Keeler Canyon form[illegible] 1,200 feet below the contact.

The middle shale member of the Owens Valley fo[illegible] tion is exposed only in the northwestern part of [illegible] quadrangle along the foot of Conglomerate Mesa. [illegible] approximately 200 feet thick, but the incompeten[illegible] the beds and poor outcrop preclude an accurate mea[illegible] ment of the thickness. The middle member consists [illegible] ponderantly of shale but includes subordinate silts[illegible] and limestone. Most of the shale is brick red or yello[illegible] brown on both fresh and weathered surfaces, but [illegible] is dark gray or greenish-gray.

The upper limestone conglomerate member forms [illegible] resistant capping and cliff exposures of Conglom[illegible] Mesa. It has a minimum thickness of 180 feet in [illegible] Darwin quadrangle, and consists of limestone cong[illegible] erate, siltstone, and sandstone. The contact with [illegible] underlying middle shale member is disconformable [illegible] the adjacent Ubehebe Peak quadrangle the limes[illegible] conglomerate in the stratigraphic equivalent upper [illegible] of the Bird Spring(?) formation has a maximum th[illegible] ness of 600 feet (McAllister, 1955, p. 14). The cong[illegible] erate contains fragments of gray limestone and [illegible] limestone mostly 1 inch to 4 inches in diameter [illegible] sand-sized matrix of limestone and chert. In places [illegible] conglomerate has been nearly completely silicified.

The age of the Owens Valley formation ranges [illegible] late Wolfcamp (Permian) to probably Guadalupe ([illegible] mian). The lower limestone member ranges in age [illegible] late Wolfcamp (Permian) into Leonard (Permian). [illegible] faunal assemblage includes fusulinids, corals, bra[illegible] pods, ammonites, and gastropods.

Two collections from near the base of the Owens V[illegible] formation in the northwestern part of the quadra[illegible] were studied by R. C. Douglass of the U. S. Geolo[illegible] Survey and were determined as probably late Wolfc[illegible] in age. Collection F-9645 is 2.85 miles S. 86½° E. of [illegible] northwest corner of the quadrangle; collection F-96[illegible] 2.20 miles S. 80° E. of the northwest corner. The des[illegible] tions by Douglass are given below.

F-9645 Permian
California, Inyo County, Darwin quadrangle
Schubertella sp.
Triticites? sp.
Schwagerina sp.
Pseudoschwagerina? sp.

"The material in this collection is fractured and silicifie[illegible] is of Permian age, probably upper Wolfcamp."

F-9648 Permian
California, Inyo County, Darwin quadrangle
Schwagerina spp. advanced forms
Pseudoschwagerina sp.

"This sample is of Permian age, probably upper Wolfcamp[illegible]

Two collections were made at the top of the lo[illegible] member of the Owens Valley formation. Collec[illegible] F-9650 of fusulinids was from a limestone lens 40 [illegible] thick in silty limestone 1.20 miles S. 71° E. of the no[illegible] west corner of the quadrangle. Collection F-119 is [illegible] miles S. 58° E. of the northwest corner. It is a collec[illegible] of gastropods, corals, brachiopods, and bryozoa fro[illegible] craggy limestone lens 84 feet thick that is stratigra[illegible] ically a few feet below collection F-9650.

C. Douglass studied collection F-9650 and reports:

550 *Permian*
California, Inyo County, Darwin quadrangle

There are many small forms in this collection most of which n to be immature individuals of the following genera, but e of which may be *Endothyra* and *Schubertella*.

Schwagerina spp. advanced forms related to *S. guembeli* Dunbar and Skinner
Parafusulina sp.

his sample is the youngest of the lot studied for this report. s Permian in age and is probably equivalent to the Leonard."

nes Steele Williams of the U. S. Geological Survey 53 summarized results of paleontological studies of gafossil assemblage collected from locality F-119 the top of the lower limestone member as follows:

ozoa (identified by Helen Duncan)
tenodiscus? sp. indet. (no close age significance)

chiopoda
eekella sp. indet. large form
ictyoclostus sp. indet., related to *D. ivesi bassi* McKee
ictyoclostus? sp. indet., possibly related to *D. ivesi* (Newberry)
nteletes? sp. indet.

tropods
hree specimens of gastropods were reported on separately by Ellis Yochelson.

wo are indeterminate and one represents an undetermined species of the genus *Peruvispira* which was described from beds said to be of "Lower Permian" age in Peru but has been found in beds in the U. S. that range from Wolfcamp to Word in age."

The large *Dictyoclostus* in the above list is crushed and inplete but as nearly as one can tell it is probably a *D. ivesi* ety *bassi* McKee. The smaller one is related to *D. ivesi* wberry) as restricted by McKee but it appears to have ser costae and a deeper sulcus than are typical of that ies. The species of *Meekella* in mature individuals is larger most Pennsylvanian species. On these rather slender grounds lieve that the collection is probably of Leonard or younger nian age. It is not the typical Owenyo fauna but appears to to be older than that fauna. I do not believe it is as old as cal McCloud. It may however be an unusual facies of one iese faunas."

fossils were found in the middle shale member of pper limestone conglomerate member of the Owens y formation. The middle shale member is probably onard or later Permian age as it conformably overne lower member, the upper part of which contains s that are considered by James Steele Williams to Leonard or later Permian age as cited above. On asis of Owenyo fauna and fossils from time-equiv- rocks in the New York Butte quadrangle, Merriam ves the limestone conglomerate member is Permian, ably Guadalupe.

Plutonic Rocks of Mesozoic Age

utonic rocks are exposed at the surface over approx-ely 10 percent of the quadrangle, and possibly 10 nt more underlie a thin cover of basalt or alluvium. ons include the batholith of Hunter Mountain in the eastern part of the quadrangle, the batholith of the Range in the southwestern part, and the stocks in Darwin Hills, Talc City Hills, and at Zinc Hill. Most e plutonic rocks fall into two lithologic types—e-hornblende quartz monzonite and leucocratic z monzonite. Small bodies of leucogranite, aplite, and pegmatite are common at the border of bodies of quartz monzonite and as thin dikes intruding them.

Biotite-Hornblende Quartz Monzonite

Biotite-hornblende quartz monzonite is the predominant rock type in the batholith of Hunter Mountain, in the batholith of the Coso Range, and in the stock in the central part of the Darwin Hills. Biotite-hornblende quartz monzonite crops out in the batholith of Hunter Mountain in steep, east-trending canyons where the rock has been exposed by faulting or by erosion of the overlying basalt. This batholith extends northward into the Ubehebe Peak quadrangle where it has been described as the Hunter Mountain quartz monzonite by McAllister (1956). In the Darwin Hills and the Coso Range, biotite-hornblende quartz monzonite is the most easily weathered rock, and forms gentle slopes that commonly are gruss covered. Locally resistant leucocratic differentiates crop out that do not reflect the composition of the gruss-covered areas.

The biotite-hornblende quartz monzonite in Rainbow Canyon and in the canyon to the north probably are satellitic to the batholith of Hunter Mountain and separated from it by Paleozoic rocks of Devonian and Mississippian age beneath a volcanic cover. Two other small masses of biotite-hornblende quartz monzonite at the south end of the Santa Rosa Hills are also satellitic to the batholith of Hunter Mountain. The southerly one, about one mile north of State Highway 190, contains gently dipping flow structures shown by oriented minerals and by light-colored schlieren and is probably a flat-lying concordant intrusion.

Petrography

The biotite-hornblende quartz monzonite is a light-gray rock that has a speckled appearance produced by a scattering of dark ferro-magnesian minerals. The texture ranges from equigranular, with an average grain size of 2 to 3 mm, to porphyritic, with 10 to 20 percent phenocrysts of pinkish potassium feldspar as much as 1½ cm long in a finer grained light-gray equigranular groundmass. The uncontaminated rock is predominantly quartz monzonite in composition but ranges from granodiorite to quartz monzonite. Essential minerals are quartz, potassium feldspar, and plagioclase; commonly at least five percent hornblende and biotite are present. Feldspar makes up 62 to 76 percent of the rock; plagioclase and potassium feldspar are in about equal quantities. Plagioclase is calcic oligoclase or andesine of composition An_{28} to An_{45}, and it is commonly normally zoned. The potassium feldspar is microperthitic; some of it has microcline twinning. Quartz makes up as much as 30 percent of the rock. It is more abundant in the quartz monzonite from the batholith of the Coso Range than that from the batholith of Hunter Mountain. The mafic minerals include biotite, hornblende, and, in the batholith of Hunter Mountain, augite, and they range in volume percent from 8 to 30. Hornblende is predominant in the quartz monzonite from the Coso Range and from the batholith of Hunter Mountain, and biotite is predominant in the quartz monzonite underlying the low hills west of Darwin. Minor accessory minerals are sphene, apatite, magnetite, and tourmaline. Tourmaline is particularly abundant in the satellite bodies south of the Santa Rosa Hills.

The Darwin stock is an heterogeneous intrusive composed predominantly of biotite-hornblende quartz monzonite and granodiorite similar to that in the Coso Range, but the rocks are deeply weathered and few unaltered specimens were found for study. Near the Defiance and Thompson workings of the Darwin mine the intrusive is contaminated and consists largely of granodiorite, quartz diorite, and diorite.

Megascopically the biotite-hornblende quartz monzonite from the batholith of Hunter Mountain, the batholith of the Coso Range, and the least contaminated parts of the stock of the Darwin Hills are similar in color and texture. However there are some overall differences between quartz monzonite from the different plutons. The quartz monzonite in the batholith of the Coso Range contains more quartz and less mafic minerals than the batholith of Hunter Mountain. Augite is a common mafic mineral in the batholith of Hunter Mountain but was not observed in the batholith of the Coso Range. These differences are believed to be due mainly to assimilation of limestone by the batholith of Hunter Mountain rather than to a difference in the parent magmas. The central part of the batholith of Hunter Mountain in the Ubehebe Peak quadrangle (McAllister, 1956) is also relatively low in quartz, and it is probable that the exposures of the batholith are closer to the former roof than the exposures of the batholith of the Coso Range.

Border Facies. The border facies of quartz monzonite of the batholith of Hunter Mountain are quartz-poor rocks that include monzonite, syenodiorite, and gabbro. Generally the border facies rocks are slightly coarser grained and are darker than the typical quartz monzonite, but in some exposures the two are nearly indistinguishable. Except for the low quartz content, monzonite is similar to quartz monzonite in mineralogy and texture. Syenodiorite megascopically also is similar, but in thin section it is seen that some of the amphibole is hastingsite instead of hornblende. The syenodiorite that contains hastingsite also contains minor tourmaline and scapolite in veinlets transecting and replacing plagioclase.

Leucocratic Quartz Monzonite
Distribution

Leucocratic quartz monzonite is present in the stock in the Talc City Hills and in the stock at Zinc Hill in the Argus Range. Most slopes underlain by the stock in the Talc City Hills are gruss covered and only a few shallow gullies expose relatively unweathered rock. The stock at Zinc Hill is in an area of rugged relief and is well exposed.

Petrography

Leucocratic quartz monzonite is a medium- to course-grained, light grayish-pink rock that at most places contains less than five percent mafic minerals. The texture ranges from equigranular to porphyritic; locally the rock contains pink feldspar crystals as much as $1\frac{1}{2}$ cm long in a medium-grained equigranular groundmass. Dark fine-grained discoidal inclusions less than $1\frac{1}{2}$ inches long are sparsely disseminated through the stock in the Talc City Hills. The leucocratic quartz monzonite is lighter colored and coarser grained than the more widespread biotite-hornblende-quartz monzonite.

Essential minerals in the rock are quartz, plagioclase, and orthoclase. Feldspars constitute 70 to 75 percent of the rock and are present in about equal quantities. Orthoclase is microperthite and commonly forms phenocrysts that poikilitically enclose all the other minerals. Plagioclase is sodic oligoclase. Biotite is the predominant mafic mineral and generally constitutes less than five percent of the rock, although as much as seven percent has been observed; it is in part altered to chlorite. Hornblende may be present in small quantities. Minor accessory minerals are allanite, apatite, magnetite, pyrite, sphene, and tourmaline.

Other Intrusives

A body of diorite, gabbro, epidote amphibolite, and amphibolite described briefly by Hopper (1947, p. 2) crops out in Darwin Canyon in the vicinity of Darwin Falls. This diorite and amphibolite body grades into hornfels of the Owens Valley formation and is nonconformably overlain by olivine basalt of late Cenozoic age. The amphibolite is a heterogeneous, fine-grained, greenish-gray rock cut by stringers and lenses of epidote. Numerous dioritic dikes cut the surrounding hornfels close to its contact with the main diorite body. In places bedding of the adjacent hornfels extends into the diorite and amphibolite body and is preserved in it. Contacts between the diorite and hornfels are gradational over distances of 10 to 20 feet. The diorite is believed to have formed from the alteration of impure limestone of Permian age by hydrothermal solutions from a buried intrusive.

Age

In the Darwin quadrangle the age of the granitic rocks can be determined only as younger than Permian and older than late Cenozoic. In the Inyo Mountains granitoid rocks intrude shale and volcanic rocks of Triassic age (Knopf, 1918, p. 60). David Gottfried (oral communication, 1955) of the U. S. Geological Survey reports the Hunter Mountain quartz monzonite to be 99 million years old (middle Cretaceous) based on zircon determination by the Larsen method of a sample collected by the writers from the southeast part of the Ubehebe Peak quadrangle. This is about the same age as that determined for the Sierra Nevada batholith (Faul, 1954, p. 265).

Hypabyssal Rocks

Hypabyssal rocks include dikes of andesite porphyry, diorite, and alaskite. Andesite porphyry dikes are widely distributed in the rocks of Paleozoic age and are unconformably overlain by volcanic rocks of late Cenozoic age. The dikes are 2 to 6 feet thick and strike about N. 70° and dip nearly vertically. They are greenish-gray on fresh surfaces and weather to shades of brown. The andesite porphyry dikes are highly altered and consist of plagioclase phenocrysts with saussuritic alteration in a fine-grained pilotaxitic groundmass composed mainly of albite, epidote, chlorite, calcite, and stilbite. An alaskite porphyry dike crops out half a mile east of Ophir Mountain. This dike contains phenocrysts of albite and quartz 2 to 4 mm long in a cryptocrystalline groundmass composed of albite, quartz, and minor epidote and chlorite. The dikes are Cretaceous or younger in age. The and ıyry dikes intrude Cretaceous quartz monzonite and onconformably overlain by Pliocene(?) pyroclastic . They are considered to be Cretaceous(?) in age.

Volcanic Rocks and Sedimentary Deposits of Late Cenozoic Age

cks of Tertiary and Quaternary age are widely buted throughout the Darwin quadrangle. They can vided into three groups: (1) Pliocene(?) and Pleise sedimentary deposits; (2) volcanic rocks of late zoic age; and (3) Recent alluvial deposits. The ages e Tertiary and Quaternary deposits are not well mented. Even the relative ages of the rock types is questionably known, as each rock type is genern a separate area within the quadrangle with little interlayering between types to show relative stratinic positions. A tentative correlation is made in 2.

ɔle 2. *Tentative correlation of Tertiary and Quaternary volcanic and sedimentary rocks.*

Age	Volcanic rocks	Sedimentary deposits
		Alluvium including fanglomerate, playa deposits, and minor lacustrine deposits
cene	Basalt flows Basalt flows and minor tuff	Darwin Wash lake beds of Hopper Fanglomerate derived from the Argus Range Coso formation of Schultz and fanglomerate derived from the Inyo Mountains
ıe?	Poorly bedded agglomerate, minor pumice Andesite Poorly bedded agglomerate, mainly red to reddish purple in color. Some basalt dikes and flows. Well-bedded tuff and tuff-breccia, mainly yellow and yellowish brown.	

ene(?) and Pleistocene Sedimentary Deposits

liocene(?) and Pleistocene sedimentary rocks ine fanglomerate from the Inyo Mountains, Coso ge, and Argus Range and lacustrine deposits in Dar- Wash. The best known deposit is the Coso forma- of Schultz, the rocks of which have been described Knopf (1918, p. 51), Schultz (1937, p. 78), and pper (1947, p. 415). The formation is exposed in the ern part of the quadrangle on both sides of State hway 190. It forms low, white dissected hills that rude 5 to 30 feet above Recent alluvium. The forma- consists largely of alluvial-fan material that was ved from disintegrated granite in the Coso Range, locally it contains pumice and fragments of basaltic ia and andesite. The formation overlies the batholith he Coso Range and locally is conformably overlain basaltic tuff and olivine basalt. It has been tilted by in-Range faults to measured dips as great as 40° the more extensive exposures west of the Darwin quadrangle. Schultz (1937, p. 98), on the basis of vertebrate fossils found west and southwest of the Darwin quadrangle, believes that the formation was formed during the transition period between Pliocene and early Pleistocene.

Erosional remnants of dissected fans are marginal to the Inyo Mountains and to the Argus Range. The fanglomerate at the south end of the Inyo Mountains contains fragments of dolomite, limestone, and quartzite of Ordovician to Devonian age in a clay and silt matrix. It probably is the same age as the nearby Coso formation of Schultz.

The fanglomerate on the west slope of the Argus Range consists of fragments of Pennsylvanian and Permian limestone, quartz monzonite, agglomerate, and olivine basalt in a predominantly sandy matrix. The fan is overlain by, and in part interfingers with, the Darwin Wash lake beds of Hopper (1947). The fanglomerate dips 4° to 6° W., but it has been tilted locally to low east dips.

Conspicuous white lake beds crop out in Darwin Wash east and southeast of Lane Mill. The essentially horizontal beds have a maximum exposed thickness of 58 feet, but the base is unexposed. The lake beds consist of white, fine-grained pumiceous ash, silt, clay, and diatomaceous earth in beds half a foot to 4 feet thick. The lake beds have been dated as middle to late Pleistocene in age by K. E. Lohman (written communication) on the basis of diatoms.

The upper part of the fanglomerate from the Argus Range interfingers with the Darwin Wash lake beds of Hopper and is therefore middle to late Pleistocene in age and is younger than the Coso formation of Schultz of late Pliocene or early Pleistocene age.

Volcanic Rocks

Volcanic rocks, which cover about 30 percent of the quadrangle, include basalt, andesite, basaltic pyroclastics, and minor pumice. Basaltic pyroclastics are the oldest volcanic rock. Andesite and pumice are interbedded near the top of the pyroclastics. Olivine basalt is the youngest rock and is the resistant capping that forms mesas and plateaus in the Inyo Mountains and on Darwin Plateau.

Pyroclastic rocks are widely distributed throughout the northern half of the quadrangle and are best exposed in the Inyo Mountains at the Santa Rosa mine and in the basin a mile and half southwest of the Santa Rosa mine. The section has a maximum thickness of 910 feet near local vents. Pyroclastic rocks rest nonconformably on Paleozoic rocks and granitic rocks. The pyroclastics are unconformably overlain by olivine basalt flows. Most of the pyroclastics dip less than 25°, but dips as much as 41° were measured beneath nearly horizontal basalt, indicating a period of tilting prior to the extrusion of the basalt.

The pyroclastic rocks consist of agglomerate, tuff-breccia, lapilli-tuff, scoria, volcanic cinders—all of basaltic composition—and locally, thin layers of pumice. The lower part of the pyroclastic section contains of well-bedded light-brown and yellowish-brown basaltic tuff and tuff-breccia. The upper part is poorly bedded and consists mainly of red or reddish-brown agglomerate, cinders, volcanic breccia, tuff-breccia, and scoriaceous basalt.

Andesite is exposed over an area of about 3 square miles south and southeast of the Santa Rosa mine. This andesite crops out in bold reddish cliffs and forms a broad dome interbedded in the upper part of the pyroclastics. It is a red or gray porphyritic rock containing phenocrysts and clusters of plagioclase as long as 10 mm and euhedral phenocrysts of hornblende as long as 4 mm in an aphanitic groundmass. The gray variety is light gray on fresh surfaces and weathers dark gray; the other variety is red to reddish gray on fresh surfaces and weathers reddish brown. The red andesite owes its color to oxyhornblende and hematite.

Petrographically, the andesite consists of plagioclase of composition An_{46} to An_{34}, hornblende or oxyhornblende, biotite, volcanic glass, and minor amounts of cristobalite, quartz, orthoclase, augite, apatite, and zircon.

Olivine basalt covers a large part of the northern two-thirds of the quadrangle, and it is present in several isolated patches in the southern one-third of the quadrangle. It is in flows 10 to 100 feet thick with a maximum aggregate thickness of about 600 feet. Thin basalt dikes, some representing feeders for the flows, are abundant near volcanic vents. The basalt is dark gray on fresh surfaces and weathers dark yellowish brown or to brownish-black desert-varnished surfaces. Vesicles are abundant near the tops and bottoms of the flows and in some of the dikes. The basalt is finely porphyritic with 1- to 2-mm phenocrysts of olivine, and a few smaller phenocrysts of plagioclase and augite, in a fine-grained groundmass consisting of plagioclase, olivine, augite, biotite, and volcanic glass. Secondary minerals are iddingsite, antigorite, goethite, calcite, and chalcedony. Minor embayed quartz fragments, probably xenocrysts, are in some of the basalt. The plagioclase is labradorite of composition An_{57} to An_{60}.

Age

The age of the volcanic rocks is only tentatively given in table 2 as their relationship with known Cenozoic deposits is not well established. The basaltic pyroclastic rocks are probably Pliocene in age. Fragments of basaltic agglomerate and scoria that are probably time equivalents of the basaltic pyroclastics in the Inyo Mountains are abundant in the Coso formation of Schultz on the west side of the Coso Range east of Haiwee Reservoir. If the pyroclastics are equivalents, they are older than the Coso formation of Schultz of late Pliocene or early Pleistocene age.

The andesite south of the Santa Rosa mine is interbedded in the upper part of the pyroclastics and is identical to the andesite in the Coso Range east of Haiwee Reservoir. The Coso Range andesite apparently is interbedded with the lower part of the Coso formation below the fossiliferous beds described by Schultz (1937, p. 98). The Coso formation of Schultz on the west flank of the Coso Range contains fragments of andesite, but beds identical in lithology to the Coso formation of Schultz and with contiguous outcrop underlie the andesite in the Coso Range at Cactus Flat 3 miles east of Haiwee Reservoir. The andesite is probably late Pliocene in age.

Olivine basalt flows overlie the Coso formation of Schultz (1937) in the Haiwee Reservoir quadrangle (Hopper, 1947, p. 417) and in the southwestern part the Darwin quadrangle, and olivine basalt flows ove fanglomerate in Darwin Canyon near Darwin Fa They must be early Pleistocene or younger in age.

Recent Alluvial Deposits

Recent alluvial deposits cover about one-fourth of quadrangle and are particularly abundant in Lov Centennial Flat, Santa Rosa Flat, and Lee Flat. Th sediments are largely alluvial fan deposits, but incl some playa deposits and lake beds.

STRUCTURE

The Darwin quadrangle is on the west limb of major anticlinorium, the axis of which trends appro mately N. 15° W. near the crest of the Panamint Ra about 15 miles east of the quadrangle. The Paleoz rocks are folded and faulted. Bedding strikes predo inantly north to N. 30° W. and dips southwest, exc in the Talc City Hills where the strike is N. 60°-80° as a result of deformation by forceful intrusion of batholith of the Coso Range. Thrust faults and ste faults, some probably with large strike-slip displaceme were formed during the late Mesozoic orogeny. Ba and Range faults of Cenozoic age are important in for ing the present topography.

The only major unconformity truncates the Paleoz rocks and the Cretaceous plutonic rocks. Minor unc formities are represented in the Pennsylvanian a Permian strata by recurrent limestone-pebble conglo erates and by local angular discordances. Pronounc differences in lithology between formations of Paleoz age may represent minor hiatuses.

The Paleozoic rocks are deformed into broad op folds with moderate dips at distances greater than se eral miles from a major intrusive. The trend of the fol is north to N. 20° W. Within 2 to 3 miles of the bat lith of the Coso Range in the Darwin Hills and Ta City Hills folding is much more intense and bedding overturned. Inverted anticlines and synclines are co mon, and faults are abundant. The structure of t Darwin Hills is an overturned syncline with an axi plane that strikes N. 15° W. and dips about 50° along the eastern margin of the hills. The rocks ran in age in a conformable sequence from Devonian on t west to Permian on the east. Bedding, which is ove turned, strikes north and dips predominantly to t west, except locally on limbs of minor folds. The stru ture in the Talc City Hills is also synclinal; Devoni and Silurian rocks are in the core and Ordovician roc on the flanks of the syncline (pl. 2).

Two general periods of faulting are recognized—a la Mesozoic period of faulting and late Cenozoic faulti producing the present basin-and-range topography. La Mesozoic faults include thrust faults and steep fau that have mainly a strike-slip displacement. The maj thrust fault is in the Talc City Hills where rocks Devonian to Ordovician age have been thrust towa the northeast over limestone of predominantly Penns vanian and Permian age. The stratigraphic throw on t fault is 5,900 feet, and the net slip is estimated to 3.6 miles. The Davis thrust is an important ore contr ling structure in the Darwin Hills.

trike-slip faults are common in the Darwin Hills . the Santa Rosa Hills. The Darwin tear fault is the jor fault in the Darwin Hills. It is a left-lateral transse strike-slip fault with a displacement of 2,200 feet, th side west. Strike-slip faults in the Santa Rosa ls are also left lateral, but the net slip is not known. 'aults of late Cenozoic age account for many of the sent topographic features. These faults strike north dip steeply. Most of them are normal faults with an echelon pattern. A swarm of Basin-Range faults in northeastern part of the quadrangle is responsible the escarpment on the west side of Panamint Valley. t of the faults are normal faults with their downwn side to the east, but some are reverse faults with valley or east side faulted up. Another swarm of ts on the western flank of the Argus Range forms a es of step-like benches. The cumulative vertical disement on these faults is about 1,600 feet; in the heastern part of the quadrangle on the west side Panamint Valley it is about 2,000 feet. The Basinge faults are less conspicuous in other parts of the drangle.

ORE DEPOSITS

he Darwin quadrangle is best known economically its deposits of lead-silver-zinc ore, but in addition, tungsten, antimony, copper, and gold have been luced, and vast deposits of limestone and dolomite known. The total value of the ore produced from 5 to 1952 is approximately $37,500,000. Production the Darwin district has accounted for $29,000,000 his amount. Most of the silver, lead, and zinc was ed from the Darwin Hills. Smaller deposits have developed in the Zinc Hill area, the Lee district, at the Santa Rosa mine. Steatite-grade talc has been ed continuously since 1917 from the Talc City Hills, cipally from the Talc City mine. The only other modity exploited in any quantity is tungsten, which first produced in 1941 from mines on the east side he Darwin Hills, and intermittent production has maintained since then.

History

xidized silver-lead ore bodies were discovered at win in November 1874 (Chalfant, 1933, p. 274), and reen 1875 and 1880 the rich near-surface ores were ed extensively. The town of Darwin was reported to had a population of 5,000 people by 1880 (Kelley, , p. 507). Between 1875 and 1877 three smelters built near Darwin—the Cuervo with a capacity of ons per day, the Defiance with a capacity of 60 and the New Coso with a capacity of 100 tons odyear, 1888, p. 226).

May 1875 the New Coso Mining Company pured the Christmas Gift and Lucky Jim mines, then prospects, and under the management of L. L. nson the company recovered 226,672 ounces of silver 1,920,261 pounds of lead by April 1, 1877, (Robin-1877, p. 38) with a total value of $410,350. By 1883, ,000 in bullion had been recovered, but the props were idle at that time (Burchard, 1884, p. 164). ne Defiance and Independence mines were in proion by 1875 as reported in the Coso Mining News ecember 24, 1875, and by 1883 they yielded bullion worth $1,280,000. The district was nearly dormant by 1888 owing to the exhaustion of the easily mined, high-grade, near-surface ores (Goodyear, 1888, p. 226), and properties were operated only intermittently by lessees until World War I.

The history from World War I until 1945 is quoted from Norman and Stewart (1951, p. 60).

> . . . As these surface ores [of the Darwin district] were exhausted, however, the isolation of the district and unfavorable price fluctuation of metals allowed only intermittent operation until World War I, during which some of the principal mines, the Lucky Jim, Promontory, Lane and Columbia, were operated by the Darwin Development Company, the Darwin Lead-Silver Development Company, and finally by the Darwin Silver Company. The Darwin Silver Company consolidated the Defiance and Independence mines with the others.
>
> In 1919, the brokerage firm of E. W. Wagner and Company gained control of the properties, and under the management of A. G. Kirby, installed surface equipment, prepared some of the properties for production and remodeled the Lane mill. In 1921 the Wagner Company went bankrupt, and the Wagner Assets Realization Corporation, a creditors' organization, was formed to take charge of the assets. From 1922 to 1925 A. G. Kirby operated the properties on a lease. In 1925, C. H. Lord obtained a lease and bond on the properties and operated them as C. H. Lord, Trustee, until 1927. He then formed the American Metals, Incorporated, and continued operations until the end of the year. The Wagner Assets Realization Corporation then attempted to regain possession of the properties, but certain legal difficulties were not straightened out until 1936. Two of C. H. Lord's financial backers formed the Darwin Lead Company, obtained a lease and bond on the properties, and commenced operations in the fall of 1936 and continued until the summer of 1938. The Imperial Smelting and Refining Company, Mr. Sam Mosher and Ralph Davies and associates began operating the property in 1940. Later Mr. Davies withdrew, and Mr. Mosher and an association of officers of the Signal Oil Company continued operations as the Imperial Metals, Incorporated. In March 1943, Arthur J. Theis and associates took over the operation under the name Darwin Mines, although Imperial Metals, Incorporated retained an interest. The Anaconda Copper Mining Company purchased the property on August 1, 1945.

The Anaconda Company has operated the Darwin mines since 1945, except for brief shutdowns in 1948 and from March 1954 to January 1955. Most of their production has come from the Defiance, Essex, Independence, and Thompson mines. The Lucky Jim mine was rehabilitated in 1948, but no ore has been mined from it since then.

Talc was first mined in the Talc City Hills sometime prior to 1919. Waring and Huguenin (1919, p. 126) describe operations at the Talc City mine—then called Simonds talc mine—in their biennial report for 1915-1916. In 1918 the Simonds talc mine was purchased by the Inyo Talc Company, which later became known as the Sierra Talc and Clay Company. The Sierra Talc and Clay Company operated the Talc City mine and several smaller deposits continuously since 1918.

Scheelite was recognized in the eastern part of the Darwin district during World War I and was mentioned by Kelley (1938, p. 543), but no deposits were developed until 1940. The principal production of tungsten was in 1941 and 1942 by the Pacific Tungsten Company.

Lead-Silver-Zinc Deposits

Distribution

Deposits of lead-silver-zinc are widely distributed throughout the Darwin quadrangle. The largest deposits are in the southern part of the quadrangle in the Darwin Hills north and east of the town of Darwin. Other deposits have been mined at Zinc Hill 6 miles northeast of Darwin, in the Lee district at the south end of the Santa Rosa Hills, at the Santa Rosa mine in the Inyo Mountains, and at a few small deposits in the Talc City Hills (Pl. 1).

Ore Controls

Most of the lead-silver-zinc deposits are in calc-hornfels close to an intrusive contact. The deposits in the Darwin Hills are in calc-hornfels of the lower member of the Keeler Canyon formation of Pennsylvania and Permian age. The Santa Rosa mine is in calc-hornfels of the lower member of the Owens Valley formation of Permian age. A few small deposits are in marble or limestone.

No individual formation can be considered as particularly favorable for ore deposits, although within mineralized areas certain beds are favorable. In general, all formations consisting of limestone seem to be favorable for lead-silver-zinc deposits, and formations of dolomite and quartzite appear unfavorable. The deposits in the Lee district are in the Lost Burro formation of Devonian age and the Tin Mountain limestone of Mississippian age. The Cactus Owen prospect and the Homestake mine in the Talc City Hills are in a limestone unit of the Lost Burro formation. Deposits in the Zinc Hill district are mainly in Mississippian limestone. The Silver Dollar mine is in limestone of Pennsylvanian age near a thrust fault contact with older dolomite. Dolomite and quartzite in the Talc City Hills contain talc deposits, but only the limy parts of the formations contain lead-zinc deposits.

The generalization that limestone is favorable for lead-silver-zinc deposits and dolomite is unfavorable is also true in the Cerro Gordo area northwest of the Darwin quadrangle. However, the major lead-silver mines in the Ubehebe Peak quadrangle, the Lippincott and Ubehebe mines, are mainly in dolomite (McAllister, 1955, p. 20).

Within mineralized areas, certain beds in a formation are more favorable than other beds. In the Darwin district a medium-grained wollastonite-garnet-idocrase calc-silicate rock formed from a fairly pure limestone is favorable but dense, gray or greenish-gray calc-hornfels formed from silty limestone is unfavorable. At the Zinc Hill mine all the known ore bodies are in one favorable marble bed 200 feet thick, while other limestone beds are only slightly mineralized.

Individual deposits occur within favorable horizons as replacement bodies along faults, as bedded replacements commonly near the crests of folds, and as steep irregular or pipelike ore bodies. A fault control is apparent for nearly all the deposits, although it may be only one of several controls instrumental in localizing ore. In the Darwin district, most of the ore bodies are in favorable beds in or close to steep-dipping strike-slip faults striking N. 50°-70° E. that served as feeder channels for the ore solutions. The ore is in the N. 50°-70° E. faults at the Christmas Gift, Lucky Jim, and Rip Van Winkle mines. At the Thompson mine the ore is in north-striking fractures that are close to the N. 50°-70° E. faults, and the fractures are progressively less mineralized away from the northeast-striking faults. An exception is the Essex ore body, which is in a fault that strikes N. 65° W.

Bedded replacement bodies are at the Defiance, Independence, Jackass, Custer, Promontory, Empress, and Zinc Hill mines. At both the Defiance and Independence mines the bedded replacement bodies are at the crests of gentle folds close to a granodiorite sill. The bedded ore body at the Defiance mine becomes progressively thinner outward along bedding away from the northeast-trending Defiance fault.

The largest steep pipelike ore body is at the Defiance mine; this ore body has been developed from the 400-foot level to the 1000-foot level. It is adjacent to the Defiance fault and is localized in a zone broken up by numerous small fractures that strike northerly from the Defiance fault.

In the Lee district, ore bodies are localized in flat-lying fractures between major steep-dipping faults. The flat fractures may parallel bedding or transect bedding. A similar structural environment at the Ubehebe mine has been described by McAllister (1955, p. 27) and also has been observed by the writers about 11 miles southeast of Darwin at the Defense mine in the Argus Range.

The ore bodies range in size from small pods that contain a few tens of tons of ore, as in the Lee mine, to the large bedded replacement bodies of the Independence mine or pipelike ore body of the Defiance mine in the Darwin district. The bedded ore body at the Independence mine is mineralized, although not all of it is ore grade, for a maximum strike length of 500 feet, a thickness as much as 160 feet, and a distance of 700 feet down the dip. The pipelike ore body of the Defiance mine has been developed 700 feet vertically from 125 feet above the 400-foot level to the 1000-foot level, but its total vertical extent is not delimited. The mineralized area is approximately 5,000 square feet in cross section, but it is not all ore.

Mineralogy

The minerals identified in the lead-silver-zinc deposits in the Darwin quadrangle are listed below.

Hypogene minerals	
Ore and sulfide minerals	
Andorite	$PbAgSb_3S_6$
Argentite	Ag_2S
Arsenopyrite	$FeAsS$
Bismuth (?)	Bi
Bornite	Cu_5FeS_4
Chalcopyrite	$CuFeS_2$
Enargite-famatinite (?)	Cu_3AsS_4-Cu_3SbS_4
Franckeite	$Pb_5Sn_3Sb_2S_{14}$
Galena	PbS
Guanajuatite (?)	Bi_2Se_3
Matildite	$AgBiS_2$
Pyrite	FeS_2
Pyrrhotite	$Fe_{1-x}S$
Scheelite	$CaWO_4$
Sphalerite	ZnS
Stannite	Cu_2FeSnS_4
Tetrahedrite-tennantite	$(Cu, Fe)_{12}Sb_4S_{13}$-$(Cu, Fe)_{12}As_4S_{13}$
Unknown lead-bismuth-selenium sulfosalt	
Gangue minerals	
Barite	$BaSO_4$
Calcite	$CaCO_3$
Chalcedony	SiO_2
Deweylite	$Mg_4Si_3O_{10} \cdot 6H_2O$
Diopside	$CaMgSi_2O_6$
Fluorite	CaF_2
Garnet sp. andradite	$(Ca)_3(Al, Fe)_2Si_3O_{12}$
Graphite	C
Idocrase	$Ca_6[Al(OH, F)]Al_2(SiO_4)_5$
Jasper	SiO_2
Kaolinite	$H_4Al_2Si_2O_9$
Montmorillonite	$(OH)_4Al_4Si_8O_8 \cdot xH_2O$

rtz	SiO_2
cite	$(H, K)AlSiO_4$
lastonite	$CaSiO_3$
ie minerals	
minerals	
entite	Ag_2S
lcocite	Cu_2S
ellite	CuS
zone	
lesite	$PbSO_4$
erite	$Cu_3(OH)_4SO_4$
chalcite	$2(Zn, Cu)CO_3 \cdot 3(Zn, Cu)(OH)_2$
rite	$2CuCO_3 \cdot Cu(OH)_2$
dheimite	$Pb_2Sb_2O_6(O, OH)$
chantite	$CuSO_4 \cdot 3Cu(OH)_2$
edonite	$Cu_2Pb_5(SO_4)_3(CO_3)(OH)_6$
rgyrite	$AgCl$
ssite	$PbCO_3$
ysocolla	$CuSiO_3 \cdot 2H_2O$
edite	$Ca_3Al_2F_4(OH, F)_6(SO_4) \cdot 2H_2O$
coite	$PbCrO_4$
rite	Cu_2O
arite	$ZnSO_4 \cdot 7H_2O$
sum	$CaSO_4 \cdot 2H_2O$
nimorphite	$H_2Zn_2SiO_5$
rozincite	$2ZnCO_3 \cdot 3Zn(OH)_2$
site	$K_2Fe_6(OH)_{12}(SO_4)_4$
onite (and goethite)	Hydrous iron oxide
rite	$(Pb, Cu)SO_4 \cdot (Pb, Cu)(OH)_2$
achite	$CuCO_3 \cdot Cu(OH)_2$
anterite	$FeSO_4 \cdot 7H_2O$
nbojarosite	$PbFe_6(OH)_{12}(SO_4)_4$
omorphite	$(PbCl)Pb_4(PO_4)_3$
er	Ag
hsonite	$ZnCO_3$
ur	S
adinite	$(PbCl)Pb_4(VO_4)_3$
fenite	$PbMO_4$

pogene Minerals

hypogene ore and sulfide minerals consist princi- of galena, sphalerite, pyrite, pyrrhotite, and chal- te with minor tetrahedrite, scheelite, andorite, keite, stannite, enargite-famatinite(?), matildite, th(?) and an unidentified lead-bismuth-selenium alt. Argentiferous galena is the principal ore al. It ranges in texture from coarsely crystalline s to fine-grained steel galena. Corroded inclusions rahedrite, pyrrhotite, and chalcopyrite are common galena. Some of the steel galena from the Essex contains tiny lamellar inclusions oriented along ge planes that are probably matildite that has ed from the galena. The inclusions are similar in and reflectivity to galena and are distinctly aniso- from light to dark gray. The galena with inclu- gave distinct bismuth and silver peaks on the spectrometer. Some galena from the Essex mine listinct selenium peaks on the x-ray spectrometer ay be clausthalite.

alerite is common in all the primary ore and is redominant hypogene mineral at the Zinc Hill It is commonly in coarsely crystalline masses with ge faces 1 to 2 inches in diameter. Pyrite is abun- n all the lead-zinc deposits except at the Lee mine. also widely distributed through the country rock Darwin mines. Pyrrhotite is commonest in the deep of the Thompson mine. It commonly forms a d structure with galena and sphalerite in the d ore bodies. Chalcopyrite is a minor constituent ore and occurs as corroded inclusions in sphalerite alena.

ne of the primary lead-zinc ore contains scheelite hedral and euhedral octahedral crystals $\frac{1}{4}$ to $\frac{1}{2}$ inch meter, and many euhedral crystals have been re- d loosely embedded in oxidized ore (Davis and

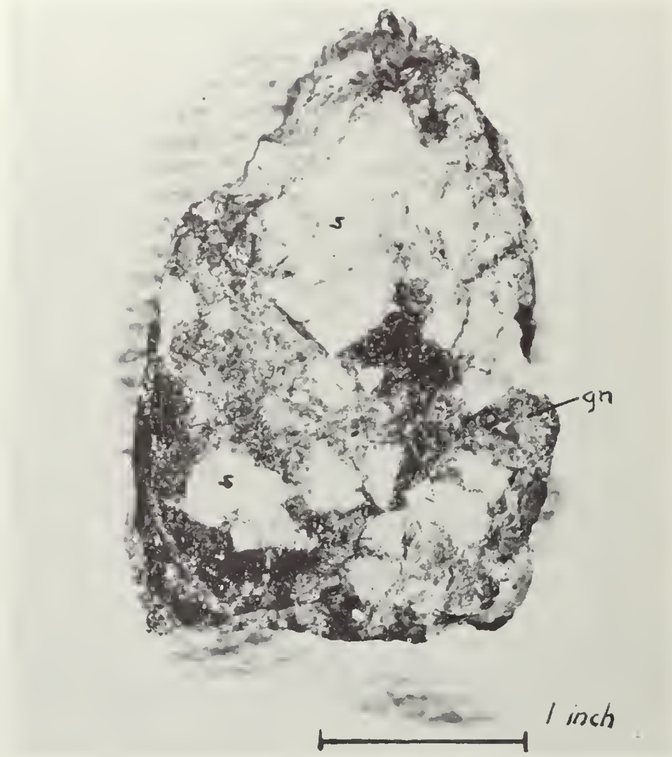


PHOTO 1. Specimen from Thompson mine showing subhedral scheelite crystals (s) embayed by galena (gn).

Peterson, 1948, p. 2). Similar crystals of scheelite surrounded and embayed by galena have been found in the deep levels of the Thompson mine (photo 1).

Franckeite, andorite, bismuth, stannite, and enargite-famatinite(?) were identified by Charles Milton of the U. S. Geological Survey from a silver-rich ore body in the 534 stope above the 400 level of the Thompson mine. Franckeite is in the silver-rich primary ore bodies that contain little galena. It is in thin, tabular, warped crystals as much as $\frac{3}{8}$ inch long that are prominantly striated. In polished section, tiny irregular white inclusions are visible irregularly distributed through the franckeite. The inclusions may be guanajuatite (Bi_2Se_3), as both bismuth and selenium were indicated by the x-ray spectrometer. Andorite is associated with the franckeite and may account for the high silver content where sulfantimonides are present. It is in thin tabular crystals similar in appearance to franckeite, but the presence of both minerals was verified by x-ray diffraction pattern by J. M. Axelrod of the U. S. Geological Survey. An unidentified lead-bismuth-selenium sulfosalt that may be a new mineral is associated with franckeite in the Thompson mine. The sulfosalt is a silver-white tabular mineral that is prominantly striated. The x-ray diffraction pattern does not agree closely with any known sulfide mineral. The presence of bismuth, lead, and selenium was indicated by the x-ray spectrometer.

The gangue minerals consist principally of calcite, fluorite, garnet, and jasper with minor barite, clay minerals, diopside, idocrase, orthoclase, quartz, and wollastonite. Both calcite and fluorite are directly associated with ore minerals. Calcite is very coarsely crystalline at some of the deposits in the Darwin Hills. Gray calcite rhombohedrons 2 to 6 inches long are abundant at the surface workings of the Defiance mine. It is also particularly abundant at the Custer mine where rhombohedrons as much as 24 inches long make up most of the vein, and the lead minerals form pockets or chimneys interstitial to the calcite. Fluorite is commonly intergrown with galena, and the miners have used it as an indicator of ore. It ranges in color from colorless to light green, light blue, or rose, and was noted at nearly all the mines in the Darwin district. Garnet, idocrase, diopside, and wollastonite were formed by recrystallization of the limestone to silicate minerals before the period of metallization, and they are in part replaced by ore minerals. Jasper is in some of the ore bodies formed in major fault zones. It is particularly abundant as a gangue mineral at the Santa Rosa mine. Only small quantities of barite are found in the Darwin district, but it is an abundant gangue mineral at the Lee mine and Silver Reid prospect in the Lee district.

Supergene Minerals

The zone of oxidation at most places in the Darwin quadrangle is deep. The ore is largely oxidized except where protected from oxidation by an impermeable layer or in the deeper levels of the Darwin mine. The oxidized ore is a porous, crumbly mass composed mainly of limonite, hemimorphite, and cerussite with some unaltered relicts of galena. At the Defiance mine the ore was mainly oxidized to the 400-foot level, and both oxide and primary ore extend from the 400-foot level to the 1,000-foot level. At the Lucky Jim mine, only small relicts of primary sulfide minerals extend down to the deepest workings on the 920-foot level. Anglesite forms a thin alteration halo around some of the galena. Hydrozincite, plumbojarosite, pyromorphite, and smithsonite are less abundant in the oxidized ore. At some places, secondary copper minerals accompany the secondary lead and zinc minerals. Aurichalcite, azurite, bronchantite, caledonite, chrysocolla, linarite, and malachite have been identified from the Darwin district. Some of the oxidized near-surface ore mined during the early history of the Darwin district is reported to have contained as much as 950 ounces of silver per ton (Raymond, 1877, p. 30). Native silver, cerargyrite, and sooty argentite are reported in the oxidized ore at Darwin (Kelley, 1938, p. 546; Davis and Peterson, 1948, p. 2; and Carlisle and others, 1954, p. 46). Euhedral crystals of cerargyrite were identified from the Lee mine. Other minerals found in small quantities in the zone of oxidation are bindheimite, creedite, crocoite, goslarite, jarosite, melanterite, pyrolusite, sulfur, vanadinite, and wulfenite. Small quantities of chalcocite and covellite are in some of the sulfide ore.

Primary Zoning

The hypogene mineralization within the Darwin area shows a general zonal distribution, which probably can be correlated with an overall temperature gradient at the time of ore deposition. In general the near-surface ore contains more lead and silver, but with depth the zinc-to-lead content increases and the silver content decreases. The Defiance workings of the Darwin mine will be used as an example. The near-surface primary ore in the bedded deposits consisted mainly of galena wit above-average content of silver. The gangue min are largely calcite, fluorite, and jasper. The upper of the steep pipelike Defiance ore body consisted pre inantly of galena that had a lower content of silver the overlying bedded deposits. Some sphalerite is pr in this ore. With increasing depth in the Defiance body the proportion of zinc to lead shows a definit crease and the silver content of the ore shows a s decrease. Pyrite also shows a marked increase in deeper levels of the mine. The gangue minerals predominantly garnet, wollastonite, and calcite. It be emphasized, however, that there are many local v tions within this general zonal distribution.

Zoning is also evident between the lead-silver bodies and the tungsten ore bodies on the east sid the stock of the Darwin Hills; the lead-silver ore b are farther out along the same faults that control t sten ore bodies.

Scheelite with little or no associated galena is foun tactite and calc-hornfels in the Fernando adit for a tance of 660 feet from the portal west to the conta the stock of the Darwin Hills. Lead-silver ore is 450 N. 70° E. of the tungsten ore—farther from the stock—in the Fernando fault at the old Fernando w ings. Similarly at the St. Charles No. 3 workings scheelite ore is close to the stock of the Darwin H and the ore at the Custer mine is localized by on the same fractures but farther from the intrusive Lane Canyon, scheelite is found in tactite along crest of an anticline 450 feet from the contact of intrusive but silver-lead ore at the Lane and Santa mines to the east is still farther from the intrusive

The Jackass mine, where both scheelite and lead-si ore are found within a few feet of each other, is exception to the zoning on the east side of the st Scheelite is disseminated in tactite while the lead-si ore with no scheelite is in a bedding plane fault at footwall contact of the tactite with calc-hornfels an undoubtedly later.

Darwin Silver-Lead-Zinc District

by W. E. Hall, E. M. Mackevett, and D. L. Davis *

The Darwin silver-lead-zinc district, which is in southern part of the Darwin quadrangle, is within New Coso mining district. The Darwin district is extensive with the Darwin Hills. The district is 39 m by paved road from Lone Pine, the nearest supply ter. The nearest railroad is at Keeler, the southern minus of the Southern Pacific Railroad Company's row gauge line from Keeler to Laws, Calif. The Anaco Company maintains a modern mining camp, inclu housing, grocery store, and recreational facilities, 1 north of Darwin.

The Darwin district can be divided into two pa Lead, zinc, and silver are the principal commodi mined in the western part, while tungsten is the p cipal commodity mined in the eastern part. Most of mines in the western part of the district have been solidated under one management since World War I, they are commonly referred to as the Darwin mi The Darwin mines consist of the Bernon, Colum Defiance, Driver, Essex, Independence, Lane, Lib

* Former resident geologist, The Anaconda Company, Darwin M

Table 3. Ore produced from the Darwin silver-lead-zinc district. †*

ear	Gold (oz)	Silver (oz)	Copper (lbs)	Lead (lbs)	Zinc (lbs)	Operator or Mine
3	--	1,571,000 (estimated)		--	--	Defiance mine; New Coso Mining Co.
2	23.51	--	--	--	--	Phoenix mine
	7.26	26,759	--	--	--	Custer mine; J. A. McKenzie; H. Mettler; Phoenix mine
	--	70,095	--	--	--	Christmas Gift mine; Henry Mettler
	--	19,362	--	--	--	Custer mine; J. A. McKenzie; Henry Mettler
		5,517	--	-	--	J. A. McKenzie and W. W. Boswell
	64	54,800	--	--	--	R. C. Troeger
	53	37,349	--	--	--	Custer mine; Last Chance Mining Co.; J. A. McKenzie; Phoenix mine
	741	13,178	--	--	--	W. W. Boswell; J. A. McKenzie; Phoenix mine
	591	14,333	-	--	--	W. W. Boswell; J. A. McKenzie; Phoenix mine
	--	4,360	--	--	--	J. A. McKenzie; Phoenix mine
	39	14,814	--	11,905	--	J. A. McKenzie
	25	12,276	--	3,200	--	Inyo County Mining and Dev. Co.; J. A. McKenzie
	24.19	5,036	2,600	2,042	--	Christmas Gift mine; Inyo County Mining and Dev. Co.
	--	3,970	--	36,842	--	C. R. Bradford; Inyo County Mining and Dev. Co.; New Coso Mining Co.
	--	12,600	--	100,000	--	New Coso Mining Co.
	4	17,785	--	182,405	--	New Coso Mining Co.
	23.87	3,271	462	75,235	--	Christmas Gift mine; New Coso Mining Co.; S. H. Reynolds
	75	11,358	904	170,609	--	New Coso Mining Co.; S. H. Reynolds
	1	4,292	--	5,667	--	C. A. Bradford; Custer mine; New Coso Mining Co.; S. H. Reynolds
	38.32	11,670	13,210	215,710	--	Christmas Gift mine; Independence Mining Co.; New Coso Mining Co.
	62.99	28,174	6,097	440,624	--	Christmas Gift mine; Custer mine; New Coso Mining Co.; J. C. Roeper; M. J. Summers
	6.02	13,043	1,256	195,667	--	New Coso Mining Co.
	3.0	10,028	314	121,363	--	Christmas Gift mine; Darwin Development Corp.; Theo Peterson
	38	103,546	27,207	1,361,401	--	Christmas Gift mine; Darwin Mines Corp.
	275	145,870	232,222	1,672,569	--	Christmas Gift mine; Custer mine; Darwin Mines Corp.; Theo Peterson; M. J. Summers
	114.61	50,568	11,854	997,038	--	A. A. Belin; Custer mine; Darwin Silver Co.; A. G. Kirby; Rooney and Bradford
	7.06	12,698	1,400	149,945	--	Custer mine; Darwin Silver Co.; Theo Peterson; M. J. Summers
	4.66	6,827	648	92,613	--	Custer mine; Darwin Silver Co.; Theo Peterson; M. J. Summers
	--	1,186	--	18,918	--	Darwin Silver Co.; A. G. Kirby
	61	89,116	7,712	937,538	--	A. G. Kirby
	152	125,899	18,098	2,026,692	--	Christmas Gift mine; A. G. Kirby
	54	40,242	8,920	731,249	76,947	A. G. Kirby
	3	10,467	3,804	84,822	--	A. A. Belin; L. D. Foreman and Co.
	31.11	33,145	4,320	978,001	--	American Metals Inc.; Christmas Gift mine; L. D. Foreman and Co.
	48	38,238	7,916	1,223,534	--	American Metals Inc.; Christmas Gift mine; L. D. Foreman and Co.
	1	635	--	22,395	--	American Metals Inc.
	90.21	1,161	1,935	21,192	--	Custer mine
	111	64,076	9,521	1,049,491	--	Custer mine; Darwin Keystone Ltd.; Darwin Lead Co.; L. D. Foreman and Co.; Louis Warnken, Jr.
	23	6,829	2,457	119,679	--	Darwin Keystone Ltd.; Darwin Lead Co.; Louis Warnken, Jr.
	5	146	--	--	--	J. B. Anthony
	7	748	170	32,712	--	Custer mine; Theo Peterson
	77	32,244	16,501	1,424,236	--	Imperial Metals, Inc.
	175	53,072	4,422	1,510,000	--	Imperial Metals, Inc.; L. D. Foreman and Co.
	--	138,662	--	4,896,000	--	Darwin Mines
	--	252,900	--	5,218,000	1,110,000	Darwin Mines; L. D. Foreman and Co.; Wonder mine
	377	575,069	130,931	10,428,000	1,992,000	The Anaconda Co.; L. D. Foreman and Co.
	442	871,091	198,307	15,416,000	1,708,000	The Anaconda Co.; L. D. Foreman and Co.
	529	1,093,709	86,690	13,102,000	1,206,000	The Anaconda Co.; Custer mine; L. D. Foreman and Co.; Wonder mine
	472	393,761	131,022	12,156,000	8,994,000	The Anaconda Co.; Custer mine; L. D. Foreman and Co.; Keystone mine; St. Charles mine
	232	352,482	130,527	9,856,000	8,124,000	The Anaconda Co.; Custer mine; Keystone mine
	361	600,440	202,829	16,958,000	10,474,000	The Anaconda Co.
	441	570,595	225,140	14,382,000	9,440,000	The Anaconda Co.; Belle Union; Lane; Promontory
	5,913.81	7,630,492	1,489,396	117,566,900	52,124,947	
	--	--	744.7	58,783.5	26,062.5	

page 19 for sources of production data.
d with the permission of the mine owners.

, Lucky Jim, Promontory, Rip Van Winkle, and
pson. In this report the name Darwin mine will
tricted to the mines through which the Radiore
passes. This includes the Rip Van Winkle, De-
Bernon, Thompson, Essex, and Independence
and each of these deposits will be referred to as
gs—the Defiance workings, Essex workings, etc.
e production of The Anaconda Company from the
n district has come from the Darwin mine. The
Darwin mines will be used in the former unre-
d sense. The mines in the eastern part of the dis-
were originally mined for their lead and silver
t, but since 1940 they have been mined only for
en.

Production

The total known production of lead, silver, zinc, copper, and gold from the Darwin district is given in table 3. The production from 1875 to 1883 was estimated by the writers from smelter returns listed in the report to the stockholders in 1877 by the New Coso Mining Company and from value of production given in early descriptions of the district in the Coso Mining News and by Burchard (1884, p. 164). The production data from 1888 to 1942 for the Darwin mines were compiled by the Mineral Production and Economics Division of the U. S. Bureau of Mines. The production figures for the other mines in the district are from annual records from the U. S. Bureau of Mines, Metal Economics Branch, San

Francisco office. All production figures are published with the permission of the mine owners. The production of lead, zinc, and silver from 1943 through 1951 is from the Minerals Yearbook.

No record of production was found for some of the smaller mines. Possibly their production was combined with shipments from other properties, and they did not receive recognition for their ore.

Grade of Ore

Before 1942 mainly high-grade oxidized silver-lead ore with some relict galena was mined from shallow workings at the Darwin mine. Smelter returns of the New Coso Mining Company prior to April 1877 show that 20.5 percent lead and 47 ounces of silver per ton of ore were recovered from its furnaces (Robinson, 1877, p. 38). Burchard (1884, p. 164) reports that ore from the Defiance and Independence mines averaged 30 percent of lead and $40 (31 ounces) of silver per ton. The grade of ore must have been very erratic as Raymond (1877, p. 30) reports ore at the Defiance mine assayed up to $1,225.29 (950 ounces) of silver per ton and 56 percent lead.

Production data compiled during World War II by the U. S. Bureau of Mines, Metal Economics Branch, indicate that 102,524 tons of ore was mined from the Darwin mines from 1902 through 1942. The average recovery from this ore was 0.03 ounces of gold per ton, 8.7 ounces of silver per ton, 0.2 percent copper, and 7.3 percent lead. The zinc content of the ore is not known, and probably little zinc was recovered.

Since 1942, production of sulfide ore from the Darwin mine has exceeded that of oxide ore. The grade of sulfide ore averages approximately 6 percent lead, 6 percent zinc, and 6 ounces of silver per ton. A considerable tonnage of high-grade ore containing approximately 20 to 30 percent lead was produced and direct-shipped from 1944 through 1952.

Geology

The rocks in the Darwin district are marble, limestone, silty limestone, shale, and siltstone in an overturned section that ranges in age from Devonian at the northwest end of the Darwin Hills to Permian on the east side. A stock intrudes the Pennsylvanian and Permian rocks along the east side of the Darwin Hills. The Paleozoic rocks strike northerly and dip predominantly to the west. Within 4,000 feet of the stock the sedimentary rocks are mostly altered to calc-hornfels, marble, and tactite.

The Lost Burro formation of Devonian age is the oldest formation present. It crops out on the west side of the Darwin Hills 3,700 feet N. 47° W. of Ophir Mountain. It is about 600 feet thick and consists of banded white and light gray coarsely crystalline marble and minor gray limestone. The marble is correlated with the Lost Burro formation on the basis of stratigraphic succession, lithology, and very poor fragmentary fossils that resemble *Cladopora*.

The Tin Mountain limestone of Mississippian age crops out in a band east of the Lost Burro formation. The formation is about 300 feet thick and consists of thin- to medium-bedded gray limestone that locally is bleached white. Fragmentary solitary corals and *Syringopora* are present. The Tin Mountain limestone is in fault contact with the Lost Burro formation, but the bedding-plane fault probably has little displacement, and almost all of the formation is believed to be present.

The Perdido formation of Mississippian age crops out on the west side of the Darwin Hills in a band approximately 350 feet thick adjacent on the east to the Tin Mountain limestone. It consists of thinly bedded medium-gray limestone, bedded chert, and siltstone. Bedding-plane faults of small displacement separate the Perdido formation from the Tin Mountain limestone on the west and from the Lee Flat on the east. The previously described formations—the Lost Burro, Tin Mountain, and Perdido—are present only at the north end of the Darwin Hills northwest of Ophir Mountain, and they project into alluvium in the vicinity of the Darwin mine.

The Lee Flat limestone of Mississippian and Pennsylvanian (?) age is the oldest formation in the Darwin mine area. It crops out from the north end of the Anaconda Company mining camp to the north end of the Darwin Hills. The formation consists of thin- to medium-bedded gray limestone that contains thin beds of chert and iron-stained hornfels. Locally the limestone is bleached white and is recrystallized to marble. The formation is about 500 feet thick, but part of the section may be cut out by faulting.

The Keeler Canyon formation of Pennsylvanian and Permian age underlies most of the Darwin Hills, and it is the host rock for most of the ore deposits in the Darwin district. It crops out along the crest and east slope of the Darwin Hills north of the Darwin mine, and constitutes all of the Paleozoic rocks in the Darwin Hills south of the Darwin mine. The formation is about 4,000 feet thick and consists of bluish-gray limestone, silty limestone, sandy limestone, pink shale, and siltstone. The lower part of the formation is mostly limestone, and the upper part contains abundant shale and interbedded limestone. The unaltered formation is well exposed north of the Darwin tear fault in the vicinity of the Darwin Antimony mine. South of the Darwin tear fault the formation is mostly altered to calc-hornfels and tactite.

The Golfball horizon, which is thinly bedded bluish-gray limestone with ½- to 1½-inch spherical chert nodules and which locally contains sparse tiny fusulinids, crops out along the western contact of the limestone sequence between Ophir Mountain and the Darwin mining camp. This horizon is characteristic of the base of the formation throughout the Darwin, New York Butte, Panamint Butte, and Ubehebe Peak quadrangles.

The Owens Valley formation of Permian age is present on the east side of the Darwin Hills 2,700 feet east of the Darwin Antimony mine and 3,500 feet east of the Christmas Gift mine. It consists of light- to medium-gray thin- to medium-bedded calcarenite, siltstone, shale, and lenses of massive pure limestone. The calcarenite commonly is cross-bedded.

The rocks of Paleozoic age are intruded by a stock along the central part of the Darwin Hills and by a small concordant pluton on the west slope of Ophir Mountain. The batholith of the Coso Range crops out locally along the west edge of the Darwin Hills.

PHOTO 2. Folded beds in the transition zone between overturned beds in the west and central parts of the Darwin Hills and ght-side-up beds on the east side. View looking south 1,700 feet southeast of the Christmas Gift mine.

tructure

ructurally the Darwin Hills are an overturned syn- with an axial plane that dips west; the syncline is ided by the stock of the Darwin Hills along the of the hills. The Paleozoic rocks west of the stock e northerly and dip mainly 30° to 70° W. in an turned section on the west limb of the overturned line. East of the stock the beds also dip west in an turned section as far east as the Lucky Jim, Christ- Gift, Wonder, St. Charles, and Durham-Fernando s, that is, about 800 to 1,200 feet east of the stock. evidence for the overturning is mainly on strati- hic succession. The oldest beds are on the west side e Darwin Hills, and the rocks become progressively ger to the east. Bedding, however, dips predomi- ly west. Paleozoic rocks on the west side are similar logically to Devonian and Mississippian rocks else- e in the quadrangle, while fossiliferous Pennsyl- an and Permian rocks underlie the central and east- parts of the Darwin Hills. The lithology of some of formations is sufficiently distinctive to recognize that ower parts of some formations are to the west. The ball horizon is the best example. The faunal evi- e is also suggestive of an overturned section, but ls are poorly preserved and the faunal evidence is conclusive except for fusulinids of late Wolfcamp (Permian) in many places along the east side of the .

ocally the upper part of the Keeler Canyon forma- and much of the Owens Valley formation is cross- led. Cross-bedding in the silty limestone of the upper er Canyon formation 2,000 feet northeast of the win Antimony mine corroborates the overturned sec- there.

ast of the Lucky Jim, Christmas Gift, Wonder, St. rles, and Durham-Fernando mines is a belt of highly -stained, dense calc-hornfels that is intensely folded. belt of iron-stained calc-hornfels is the axis of the syncline and forms the transition between overturned beds to the west and right-side-up beds along the east edge of the hills (Photo 2).

In some places, bedding in this deformed belt is readily apparent and the folds are easily resolved, but in most places the rocks are fractured and their folded nature is not apparent except by close examination. The crests of folds, in particular, are commonly shattered. Fracture cleavage locally is well developed in this deformed belt and is an aid in determining tops of beds. In tight, overturned folds fracture cleavage is usually well developed on the right-side-up limb, but it is poorly developed on the overturned limb where it tends to be nearly parallel to bedding.

The folded beds are exposed in the canyon that drains east from the Lucky Jim mine and in the canyon to the north. At the Lucky Jim mine the overturned beds strike northerly and dip west. An overturned minor syncline with an axial plane that dips west is about 600 feet northeast of the main shaft. If one continues east down the canyon from the mine, the beds may be seen to pass through several tight minor anticlines and synclines before passing into right-side-up beds with broad folds 2,200 feet east of the mine. The beds continue to dip gently east in Darwin Wash to Darwin Canyon, and the beds dip west on the east side of the canyon.

In the Durham-Fernando mine area the beds likewise are overturned and dip to the west. The axis of an overturned syncline crops out in the gully 500 feet N. 77° E. of the Durham shaft. (See pl. 9.) An open anticline is 30 feet east of the overturned syncline, and the beds pass through gentle folds with right-side-up beds continuing to the east.

At many places, although the exact nature of the transition from right-side-up to overturned beds is not evident because of inadequate exposures, some tight folds are recognized. At some places, as at the Custer mine, faults separate overturned from right-side-up beds (see pl. 9).

The Paleozoic rocks are intersected by four sets of faults. The four sets are described under the subtopic "Darwin mine" as the faults are important in localizing ore. The largest fault is the Darwin tear fault, which is a left-lateral strike-slip fault that strikes N. 70° W. Displacement on the fault is 2,300 feet, the north block moving west.

Belle Union Mine

The Belle Union mine, owned by The Anaconda Company, is in sec. 12, T. 19 S., R. 40 E., at altitudes near 5,200 feet. It is one of the old mines in the district but in recent years has been inactive. Mine workings including three shafts are largely inaccessible and their size and extent are not known. The mine is in calc-hornfels of the Keeler Canyon formation near a salient of the Darwin Hills stock. The ore is in a near-vertical vein trending N. 58° E. Observed ore minerals on the dumps and in the highly iron-stained vein include galena, cerussite, and hemimorphite.

Buckhorn Mine

The Buckhorn mine, which is owned by Andrew Sundberg, is in sec. 31, T. 18 S., R. 41 E., at an altitude of 4,240 feet. The mine is developed by two shafts, one about 30 feet deep inclined northerly at 70°, and the other inclined to the northwest at 30°. Other workings include minor pits and open cuts south of the main workings. Production from the property is small.

The mine is in silty limestone of the lower member of the Owens Valley formation. Ore is a replacement of a fault zone that strikes N. 70° E. and dips 30° N. Another fault, which strikes N. 28° W. and dips 70° N., apparently cuts off and displaces the N. 70° E. fault. Ore minerals consist of cerussite, hemimorphite, and minor galena in an iron-stained quartz-calcite gangue. The size or grade of the ore body is not known.

Christmas Gift Mine

The Christmas Gift mine is 2½ miles north of Darwin in secs. 1 and 12, T. 19 S., R. 40 E., at an altitude of 5,440 feet. The property is accessible by a dirt road 2½ miles long that branches off the Darwin to Lone Pine highway 2.2 miles northwest of Darwin. The mine is owned by C. B. Skinner of Morro Bay, Calif.

The recorded production from the Christmas Gift mine since 1893 is given in table 4. The total production from 1875 to 1893 is not known. Both the Christmas Gift and Lucky Jim mines were owned by the New Coso Mining Company during the early history of the district and the production of both mines was lumped. Burchard (1884, p. 164) reports the production of the two mines by 1883 to be $750,000. The Christmas Gift mine was worked extensively in 1875 and early 1876 according to the annual report of 1877 to the stockholders, and 8,871 bars of silver were produced from the Christmas Gift during this period (estimated by the writers to contain 83,500 ounces of silver and 700,000 pounds of lead). Apparently most of the production between the spring of 1876 and 1883 came from the Lucky Jim mine.

Table 4. Ore produced from the Christmas Gift mine since 18

Year	Ore (tons)	Gold (oz.)	Silver (lbs.)	Copper (lbs.)	Lea (lbs
1894	--	--	12,952	--	
1895	--	--	7,692	--	
1905	50	24.19	4,918	--	
1909	21	0.87	908	85	12,
1912	135	14.32	6,813	535	82,
1913	400	19.01	14,677	2,801	254,
1914	183	4.02	7,553	910	137,
1915	69	3.00	2,817	314	48
1916	368	-	2,522	4,520	90,
1917	385		14,000	--	213,
1918	235	2.61	6,027	1,279	119,
1923	7	--	256	83	2,
1926	6	0.11	115	83	2,
	52	--	615	21	10,
Total	1,911	68.13	81,865	10,631	973,

* Published with the permission of the mine owners.

The mine workings consist of 5 shafts, several ad totaling more than 600 feet in length, and many op cuts and shallow shafts. The Christmas Gift shaft v sunk on the vein to a depth of 250 feet, and a wi extends 126 feet below the 250-foot level. There a approximately 1,900 feet of levels from the shaft a winze. The Johnny John shaft is reported by Norm and Stewart (1951, p. 59) to be 250 feet deep, but was inaccessible. The other shafts are 90 to 100 feet de

The Christmas Gift area is underlain by quartz m zonite and by calc-hornfels and hornfels that is me morphosed limestone and silty limestone of the lov and upper members of the Keeler Canyon formati (pl. 3). The ore deposits are in calc-hornfels that c relates with the uppermost part of the lower meml of the Keeler Canyon formation (photo 3). The low member consists of white to light-gray dense calc-hor fels with 1- to 2-inch thick greenish-gray dense hornf bands that are metamorphosed shale. The calc-hornf of the lower member of the Keeler Canyon formati is intruded by small irregular bodies of quartz m zonite and granodiorite that line up in a northe direction. The contact with the upper member of t Keeler Canyon formation is 370 feet northeast and 8 feet east of the Christmas Gift shaft. The upper meml consists of dense greenish-gray hornfels that weathe dark brown.

Bedding is overturned in the metasedimentary roc It strikes predominantly north to N. 40° W. and di 25° to 50° W. The rocks are cut by many faults th strike N. 30°-70° E. and dip steeply northwest. The d placement where recognized is left lateral. Nearly ho zontal slickensides exposed underground confirm t strike-slip displacement on the fault through the Chri mas Gift shaft.

Ore in the Christmas Gift mine is localized in fau that strike N. 30°-70° E. Seven faults have been pro pected, but most of the ore was mined from the Christm Gift vein, which is exposed in the Christmas Gift sha Ore minerals are exposed along the Christmas Gift ve intermittently for a strike length of 700 feet and to depth of 334 feet, but only locally is the grade sufficient high to be ore. Most of the ore in the vicinity of t Christmas Gift shaft has been mined between the su face and the No. 6 level, a vertical distance of 146 fe

PHOTO 3. View looking north at Christmas Gift mine. The area is underlain by quartz monzonite and by calc-hornfels of the lower unit of the Keeler Canyon formation of Pennsylvanian and Permian age. The thrust fault near the skyline probably is an extension of the Davis thrust.

ore shoot strikes N. 40°-50° E. and dips 70°-80° ; it rakes steeply to the southwest. Average thick- of the vein is about 3 feet.

e ore is oxidized in the deepest mine workings, e only minor relicts of galena remain. The vein st predominantly of limonite and cerussite in a ue of calcite and jasper and locally they contain and green secondary copper minerals.

structural control for ore shoots related to strike of ault zone seems evident. The ore is localized where aults strike approximately N. 45° E., and the faults nly slightly mineralized where the strike is N. 65°- E. As the faults had a left-lateral displacement, the zones were open where the strike is N. 45° E.— favorable for ore deposition—and tight where the e is N. 65°-70° E. This is illustrated by the ore on the No. 10 level (pl. 4). The mineralization restricted to the part of the fault southwest of the e where it strikes N. 35° E. and dips 68° NW. The is unmineralized northeast of the winze where the e changes to N. 70° E. and the dip steepens to ap- imately vertical.

pocket of ore was mined from a shaft 670 feet N. 6° f the Christmas Gift shaft. The shaft is 98 feet deep has 5 short levels. Ore was stoped from the bottom y to the surface but the tonnage mined was small. e ore was also mined from shallow adits and open along the veins at the north end of the property.

uster Mine

e Custer mine is in sec. 19, T. 19 S., R. 41 E., on the side of the Darwin Hills a mile N. 70° E. of Dar- in the narrow canyon half a mile south of Lane mill altitude of 4640 feet. The mine is accessible by a 1 mile long that leads east from Darwin down the canyon past the St. Charles mine or by a road 1.1 miles long that heads southerly from Lane mill (see pl. 9).

The mine is owned by Harry R. Staples and Paul C. Staples of Oxnard, Calif. The property is developed by an inclined shaft 400 feet deep that bears S. 60° W. at –50°. The collar of the shaft is at an altitude of 4,641 feet and levels extend off the shaft at altitudes of 4,600 feet (50-foot level), 4,503 feet (200-foot level), 4,452 feet (250-foot level), 4,396 feet (300-foot level), and 4,308 feet (400-foot level). A winze extends 240 feet below the 400-foot level.

The recorded production from the Custer mine is 994 tons from which 96,614 pounds of lead and 10,492 ounces of silver were recovered. In addition, 6,123 ounces of silver were recovered during the 1890's from an unknown amount of ore. The total production is given below:

*Table 5. Ore produced from the Custer mine.**

Year	Tons	Gold (oz.)	Silver (oz.)	Copper (lbs.)	Lead (lbs.)	Zinc (lbs.)
1893	--	--	1,575	--	--	--
1895	--	--	3,978	--	--	--
1899	--	--	570	--	--	--
1911	21	--	1,116	--	5,667	--
1913	13	1.98	2	251	6,709	--
1917	109	--	2,020	--	15,302	--
1918	16	2.00	355	--	3,236	--
1919	8	1.19	396	--	1,615	--
1920	8	1.19	396	--	2,100	--
1935	29	90.21	1,161	1,935	21,192	--
1937	20	1.00	60	--	--	--
1940	20	6.00	304	102	2,700	--
1947	166	6.00	942	664	11,124	--
1948	579	30.00	3,635	3,254	24,295	--
1949	5	2.00	105	416	2,674	72
Total	994	141.57	16,615	6,622	96,614	72

* Published with the permission of the mine owners.

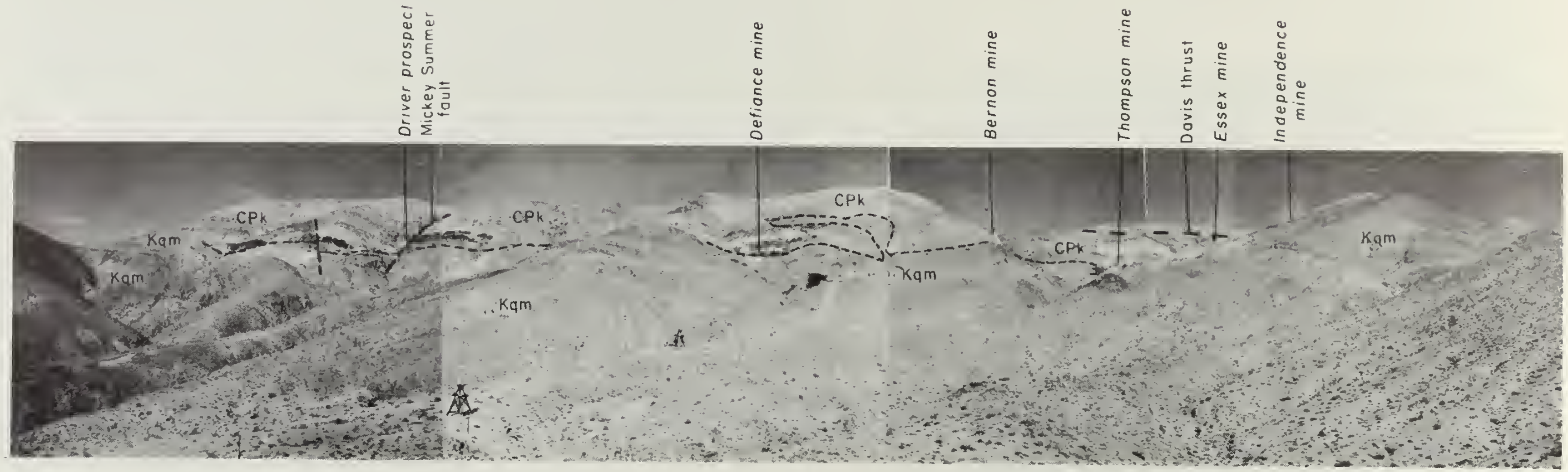


PHOTO 4. View looking west at the east slope of the Darwin Hills showing the surface workings of the Darwin mine. The smooth slopes in the foreground are underlain by the stock of the Darwin Hills (Kqm) and the skyline is calc-hornfels of the Keeler Canyon formation (CPk).

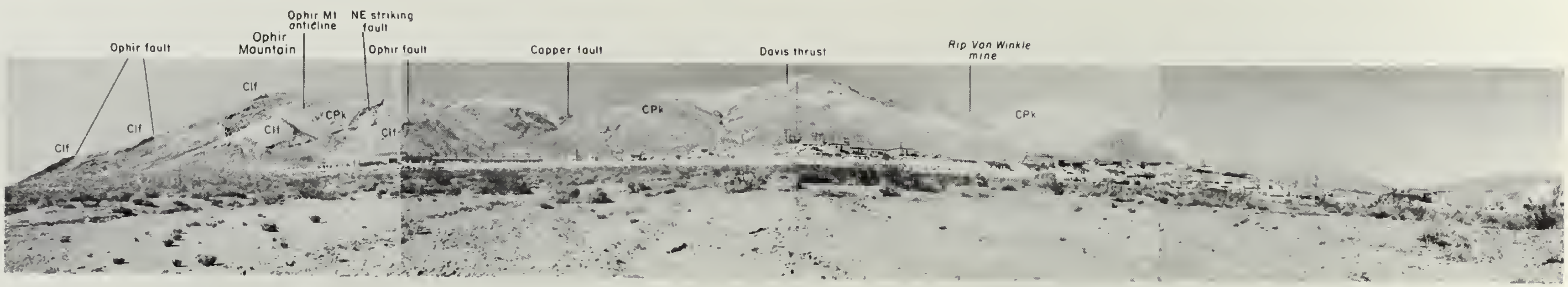


PHOTO 5. View looking east at the Darwin mining camp and the west side of the Darwin Hills. The hills are composed mainly of an overturned section of calc-hornfels of the lower part of the Keeler Canyon formation (CPk). On the left side are remnants of the Lee Flat limestone (Clf) of Mississippian and Pennsylvanian (?) age in fault contact with the Keeler Canyon formation. The Copper fault and the parallel northeast-striking fault are one of the structural controls for ore.

he uppermost part of the lower member of the ler Canyon formation crops out in the mine area. It ists of aphanitic light-gray, greenish-gray, and vn calc-hornfels and beds of bluish-gray limestone are in part altered to tactite. A fault contact be- n the lower and upper members of the Keeler Can- formation is about 150 feet northeast of the inclined t. The upper member consists of aphanitic greenish- calc-hornfels that is characteristically highly iron ned on weathered surfaces.

he Keeler Canyon formation is intruded by a quartz zonite dike 300 feet S. 65° W. of the collar of the ned shaft and by a small irregular intrusion of tz monzonite 100 feet S. 10° W. of the main shaft.

he Paleozoic rocks are folded and tilted into an over- ed section and are intersected by many faults. Bed- at the shaft strikes N. 2° W. and dips 56° SW. Paleozoic and intrusive rocks are cut by several ts that strike N. 50° to 70° E. and dip steeply either he north or south. Displacement on the faults is l.

he ore body at the Custer mine is in calc-hornfels is parallel to bedding. The bedded deposit consists lominantly of coarse calcite and quartz with pockets interstitial material composed of cerussite, galena, nite, jarosite, pink and green fluorite, and locally or amounts of malachite. The calcite is gray to white olor and commonly occurs as rhombohedrons 12 to nches on a side. Some scheelite is exposed in the ze.

he ore body is inconspicuously exposed at the sur- . On the 50-foot level it is approximately 60 feet long 6 to 10 feet thick, and is stoped for about 30 feet e the level. The shape of the ore body is lenticular lan view, and it has a long axis that pitches nearly ight down the dip. The bedded deposit is strong on the 200-foot and 300-foot levels. On the 200-foot l it is 110 feet long and is terminated on the north pre-mineral fault that strikes N. 70° E. and dips N. The thickness of the ore body is erratic. Within w feet it ranges from a few inches to 10 feet thick. ore body is stoped for about 70 feet above the level for 18 feet below the level. On the 300-foot level lead content of the ore body has decreased, and the led deposit consists mainly of quartz and calcite. It 50 feet long and a maximum of 40 feet wide. Locally ntains pockets of galena and cerussite. The calcite- tz vein extends to the 400 level, but it carries very e lead at this depth except locally at the northwest

Darwin Mine

he Darwin mine includes the workings owned by the conda Company that are developed by the 6,300-foot Radiore adit. They are the Bernon, Defiance, Essex, ependence, Rip Van Winkle, and Thompson work- and Driver prospect—most of which are visible in o 4. The mine is about a mile north of Darwin.

eology. The rocks in the Darwin mine area are stone, silty limestone, and minor siltstone in an over- ed section that ranges in age from Mississippian on west side of the Darwin Hills to Permian on the side (pl. 5). A stock intrudes the Pennsylvanian and Permian rocks along the east side of the Darwin Hills in the vicinity of the Defiance, Thompson, and Independence workings. The Lee Flat limestone of Mississippian and Pennsylvanian (?) age is the oldest formation in the mapped area. It crops out in a band along the west side of the Darwin Hills and at the top of Ophir Mountain (photo 5). It is a thin- to medium-bedded, medium- to dark-gray limestone. Locally the limestone is bleached white and recrystallized to marble close to its contact with the batholith of the Coso Range. The limestone is altered to massive, buff-colored dolomite 1,300 feet west of the Bernon workings (pl. 5). The dolomite resembles the Hidden Valley dolomite except for occasional relicts of the Lee Flat limestone.

The Keeler Canyon formation underlies most of the mine area. It is in fault contact with the Lee Flat limestone on the west side of the Darwin Hills and along the prominent ridge trending S. 60° W. from the top of Ophir Mountain. The lowermost part of the Keeler Canyon formation is exposed on the southeast side of the Ophir fault. The golfball horizon (limestone with spherical chert nodules) and limestone with sparse tiny fusulinids are in the prominent inverted syncline on the west flank of Ophir Mountain. Between the golfball horizon and the Davis thrust on the east side of the hills are interbedded bluish-gray thinly bedded limestone, silty limestone, and minor siltstone. Much of the limestone is altered to a white, gray, brown, or greenish-gray dense calc-hornfels.

Nearly all of the ore is in the Keeler Canyon formation between the Davis thrust and the stock of the Darwin Hills. The formation in this interval consists of dense white calc-hornfels and white, fine- to medium-grained calc-silicate rocks. Idocrase crystals commonly $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter are characteristic of the calc-silicate rocks on the east side of the Davis thrust and are rare or absent in the calc-hornfels on the west side of the thrust. The idocrase-bearing calc-silicate rocks are west of the stock from the Independence workings south to the Susquehanna mine. This horizon also crops out north of Ohpir Mountain as far as Belle Union mine.

The Keeler Canyon formation is intruded by the stock of the Darwin Hills in the vicinity of the Independence, Thompson, and Defiance workings, and by a nearly concordant intrusive on the southwest side of Ophir Mountain. The stock is made up of a heterogeneous mixture of diorite, granodiorite, quartz monzonite, and aplite. The intrusive rocks are deeply weathered, and north of the Defiance workings they are highly iron stained, which makes them easy to distinguish from the hard, lighter-colored calc-hornfels. The stock is composed predominantly of quartz monzonite and granodiorite. Granodiorite and quartz diorite are prevalent around the Defiance and Thompson workings but quartz monzonite and minor aplite are prevalent in the area extending from the Thompson workings to the Independence workings. Aplite also crops out south of the Defiance workings.

Quartz monzonite crops out on the west flank of Ophir Mountain as an essentially concordant intrusive 1,400 feet long and 600 feet wide. The sill is 1,100 feet east of the batholith of the Coso Range and is probably an offshoot from it. The south end of the sill is in contact with diorite and gabbro. Several small diorite and

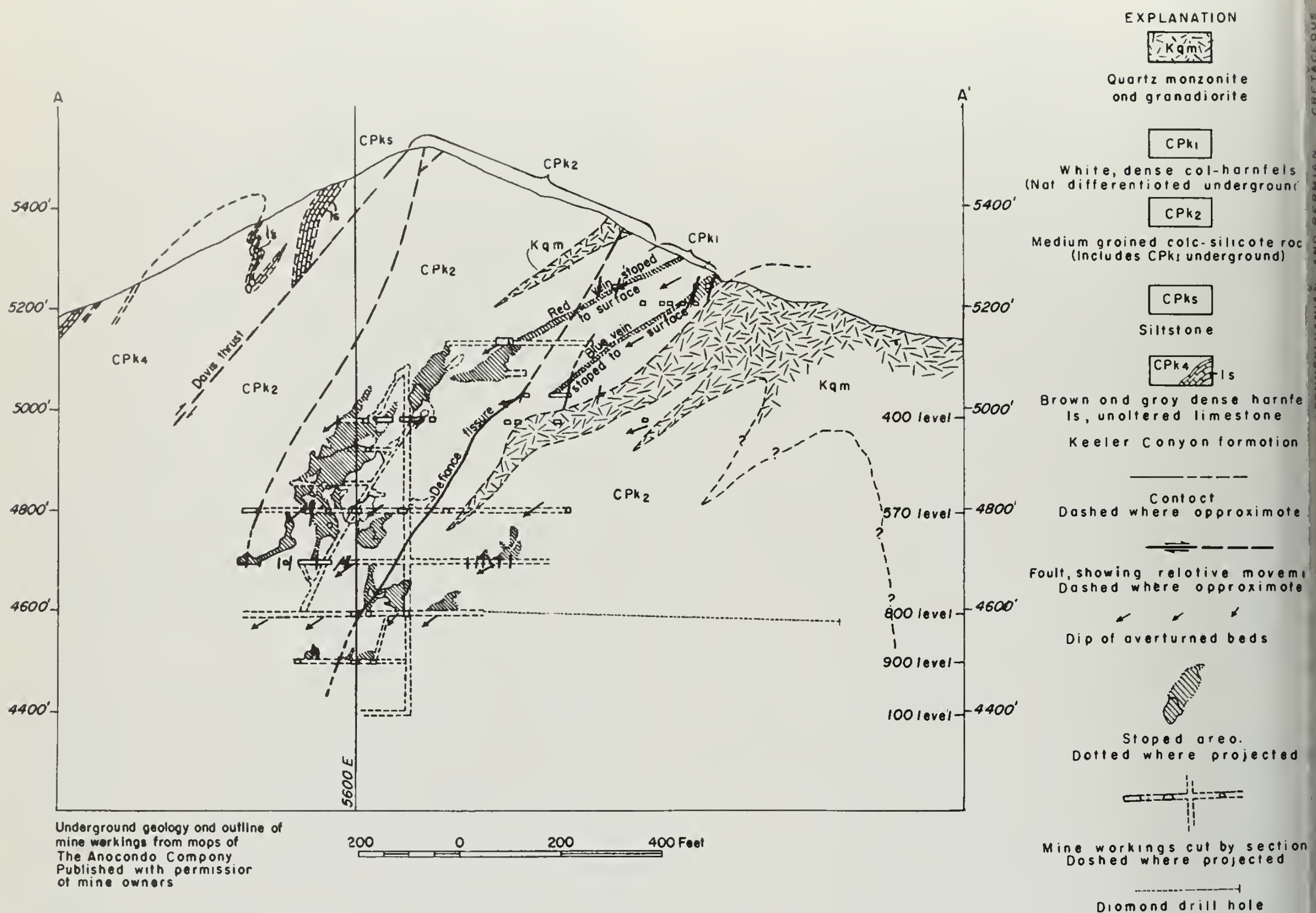


FIGURE 2. Geologic section of the Defiance workings showing stope outlines.

gabbro bodies are 200 to 700 feet west of the Bernon workings and are similar to the diorite at Darwin Falls, which is considered a granitized silty limestone.

Structure. The Paleozoic rocks in the mine area strike northerly and dip mostly 30° to 70° W. in an overturned section that ranges in age from Mississippian to Permian on the west limb of a major overturned syncline. The stock of the Darwin Hills intruded near the axis of the syncline. Several minor open folds are superposed on the overturned limb of the syncline. One of these folds on the west flank of Ophir Mountain is visible from the Darwin mining camp. The strata are folded into the form of an open anticline that plunges gently to the north, but younger strata are in the core and older rocks are on the flanks of the fold. Therefore, this fold, which commonly is referred to locally as the Ophir Peak anticline, is a minor inverted syncline according to the definition of White and Jahns (1950, p. 196). Similar inverted synclines are exposed in the Defiance and Bernon workings, in the Intermediate workings, and on the west side of the Darwin Hills adjac to the Darwin mining camp.

The Paleozoic rocks are intersected by four sets faults. One set strikes N. 50°-70° E. and dips stee to the north. Displacement on the faults is left late with the north block moving west a few feet to 100 relative to the south block. The horizontal displacem is shown by offset of beds and by abundant nearly h zontal slickensides and mullion structure exposed fault planes in underground workings. The N. 50°-70° faults are mineralized and many ore bodies are locali in or close to them. The Defiance fault, Copper fa Water Tank fault, and Mickey Summers fault are this group.

A second set strikes N. 65° W. and dips steeply. T are parallel to the Darwin tear fault, which is a l lateral strike-slip fault. The Essex vein exemplifies set.

The third set of faults are thrust faults that str northerly and dip 30° to 40° W. The Davis thrust cr along the side of the hill above the Independence, x, and Bernon workings, and at the south end of mine area it is exposed on the west side of the hills e the mining camp at the water tanks. This fault is exposed in the Essex workings and in the upper pendence workings. Right-hand drag folds localized to the fault plane indicate that the west block ed upward toward the east relative to the east block 5). The amount of displacement is not known. The ir fault is west of, and parallel to, the Davis thrust, the amount of displacement on it is small. The drag s associated with it are left-hand drag folds instead ight-hand drag folds like those along the Davis st. Four parallel faults also are exposed between Ophir fault and the alluvium on the west side of the vin Hills. The writers believe that the overthrust k above the Davis thrust broke along several parallel es as it was moving and that each underlying block ed slightly farther to the east than the overlying k. Therefore, the overlying block on the west side e Ophir fault moved downward relative to the over-st block between the Ophir fault and the Davis st. Thus, left-hand drag folds were formed along Ophir fault while right-hand drag folds were formed g the Davis thrust.

he fourth set of faults strikes northerly and dips ly steeply to the west. The displacement is small. faults are mineralized, and many of the ore bodies he district are localized along them.

re Bodies. Ore in the Darwin mine occurs mainly favorable stratigraphic zone more than 840 feet k close to pre-mineral feeder faults that strike 0°-70° E. and dip steeply to the northwest. Indi-al ore bodies occur as replacements of certain rable beds close to the N. 70° E. faults, as replace- bodies in fault zones, and as irregular or pipelike s in calc-hornfels. The bedded deposits have sharp acts with the wall rock both stratigraphically above below the favorable bed, although the ore within a eralized bed has a considerable range in grade and blocks of low grade ore were left behind as stope rs.

description of the ore bodies and ore controls for of the workings is given below.

ernon Workings. The Bernon workings adjoin the ance workings on the north and the Thompson kings on the south. The workings are in white, ium-grained calc-hornfels along the crest of a minor rted syncline that extends southward to the De-e workings. The Paleozoic rocks are intruded by a of quartz monzonite south of the 434 fault, and by ke south of the Bernon fault. The rocks are cut by pre-mineral Bernon fault and the 434 fault, both of h strike N. 50°-60° E. and dip steeply to the north-. The faults are cut off on the west by the Davis st. All ore is in the Bernon fault in medium-grained silicate rock.

efiance Workings. The Defiance workings are in southeast part of the Darwin mine area 0.7 miles h of the town of Darwin. Two bedded ore bodies out along the crest of an inverted syncline re it is cut by the Defiance fault. The Blue vein is in dense white calc-hornfels near the upper contact of a granodiorite sill. The vein is 300 feet long and has been mined 400 feet down the dip from the surface to the 215-foot level (fig. 2). The Red vein is in dense white calc-hornfels 60 feet stratigraphically above the Blue vein and 80 feet stratigraphically below an upper sill of granodiorite. This vein is 460 feet long at the Defiance tunnel level, 5 to 10 feet thick, and has been mined 670 feet down the dip from the surface to the 400-foot level. Other smaller bedded ore bodies have been mined in the deeper mine workings. Both the Red and Blue veins lie between two sills of granodiorite that are stratigraphically about 200 feet apart. Both sills pinch out in depth. The upper sill does not extend to the 110-foot level from the surface; the lower sill terminates between the 570-foot and 700-foot levels. The lower sill cannot be delimited on the surface as it merges with the main Darwin Hills stock at the level of the present erosion surface (fig. 2). The bedded ore in the Defiance workings is approximately coextensive in depth with the extent of the sills.

Below the 400-foot level the principal ore bodies change from concordant veins to an irregular, vertical replacement ore body that has been developed for 570 feet vertically to the 1,000-foot level. The ore is localized close to the Defiance fault but extends outward from the fault along closely spaced fractures for distances as much as 270 feet. On both the 800- and 900-foot levels about 25 percent of the calc-hornfels over an area 200 feet by 270 feet is replaced by ore (pl. 6). Insufficient exploration work has been done to delimit the ore on the 1,000-foot level.

Driver Prospect. The Driver prospect is 1,000 feet S. 10° E. of the Defiance workings. The prospect is developed by several small open cuts, adits, and winzes. It is in dense white calc-hornfels 30 to 50 feet west of the contact with the stock of the Darwin Hills. Bedding in the calc-hornfels strikes northerly and dips 35° to 53° W. The Mickey Summers fault displaces the contact of the quartz monzonite and calc-hornfels 75 feet, the north side moving west relative to the south side. A parallel fault cuts the calc-hornfels 230 feet south of the Mickey Summers fault.

The calc-hornfels is highly iron stained parallel to bedding close to the N. 70° E. faults. A belt of white calc-hornfels 20 to 30 feet wide is highly iron stained 30 feet west of the stock of the Darwin Hills and north of the Mickey Summers fault. Gossan 1 to 2 feet thick is locally distributed along a bedding-plane fault on the east side of the iron stained zone. The calc-hornfels is similarly heavily iron stained for 50 feet north of the fault that is south of the Mickey Summers fault and parallel to it. It is not known if any ore was mined from the shallow workings.

Essex Workings. The Essex workings are 230 feet southwest of the portal of the Independence workings and 820 feet northwest of the portal of the Thompson workings. The surface workings are in medium-grained calc-silicate rock 50 feet east of the Davis thrust. Bedding strikes northerly and dips 32° to 68° W. The calc-hornfels is cut by the Essex fault, which strikes N. 70° W. and dips vertically to very steeply south. The Essex fault is cut off by the Davis thrust.

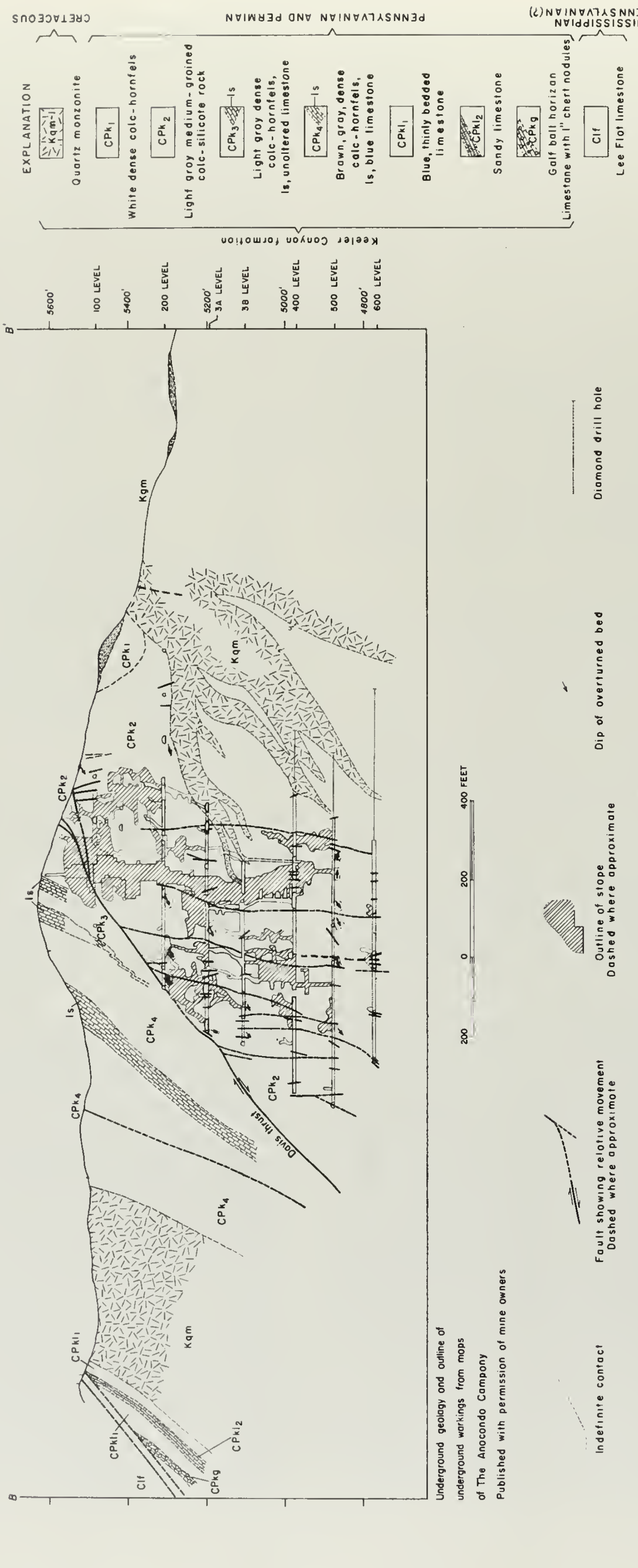


FIGURE 3. Longitudinal section of the Essex workings showing stope outlines.

re minerals are not conspicuous at the surface of the ex workings. The Essex fault is iron stained over a th of 10 feet and contains jasper near the Essex t. The open cut and short adits 40 feet northeast of shaft are on a branch of the Essex fault, and they ose only minor iron staining. The main ore body in Essex workings does not crop out at the surface, but below the Davis thrust in the Essex fault zone and g steep north-striking fractures in calc-hornfels e to both the Essex fault and an intrusive contact . 3).

re has been mined from the Essex fault from 50 feet w the surface to the 600-foot level, a vertical dis- e of 780 feet. The ore is localized in the fault in calc- ate rock between the stock of the Darwin Hills and Davis thrust. Between the surface and the 3B level, Davis thrust and the west contact of the stock are roximately parallel and are about 360 feet apart. Ore iscontinuous over this distance and has a maximum kness of 30 feet. This is one of the few places in the e where ore extends up to the Davis thrust (fig. 3). ow the 3B level the trend of the contact between the -silicate rock and the Darwin Hills stock dips verti- y or steeply to the east. As the distance between the k and the Davis thrust becomes progressively greater depth, the amount of known ore is proportionately Ore along north-striking fractures is best developed he 200- and 400-foot levels (see pl. 7, plan of 400-foot level). On the 200-foot level ore extends 175 feet north of the Essex fault, and on the 400-foot level it extends 400 feet north of Essex fault close to the intersection of a steep north-striking fault and a sill of quartz monzonite that dips 34° W. The ore is localized within 40 feet of the intrusive contact.

Independence Workings. The Independence workings are at the north end of the Darwin mine 850 feet N. 25° W. of the Thompson workings. Medium-grained calc-silicate rock is exposed at the surface in most of the area over a width of 130 feet from the stock of the Darwin Hills west to the Davis thrust. Fine-grained gabbro and diorite crop out southwest of the portal of the Independence adit around the base of the mine dump. North of the Independence workings the favorable calc-silicate rock is cut off by the Davis thrust, and an unfavorable overthrust block of dense greenish-gray calc-hornfels is in contact with the stock. Gossan is exposed at the surface in medium-grained calc-silicate rock along its contact with the stock. The contact strikes northerly and dips 43° to 72° W. A prospect pit 30 feet deep 60 feet north of the Independence adit exposes a highly iron stained zone 10 feet thick along a fault contact between the stock and calc-silicate rock. An open cut at the crest of the ridge 250 feet N. 25° E. of the Independence adit exposes gossan about 20 feet thick that dips 43° W. along the calc-hornfels-intrusive contact.

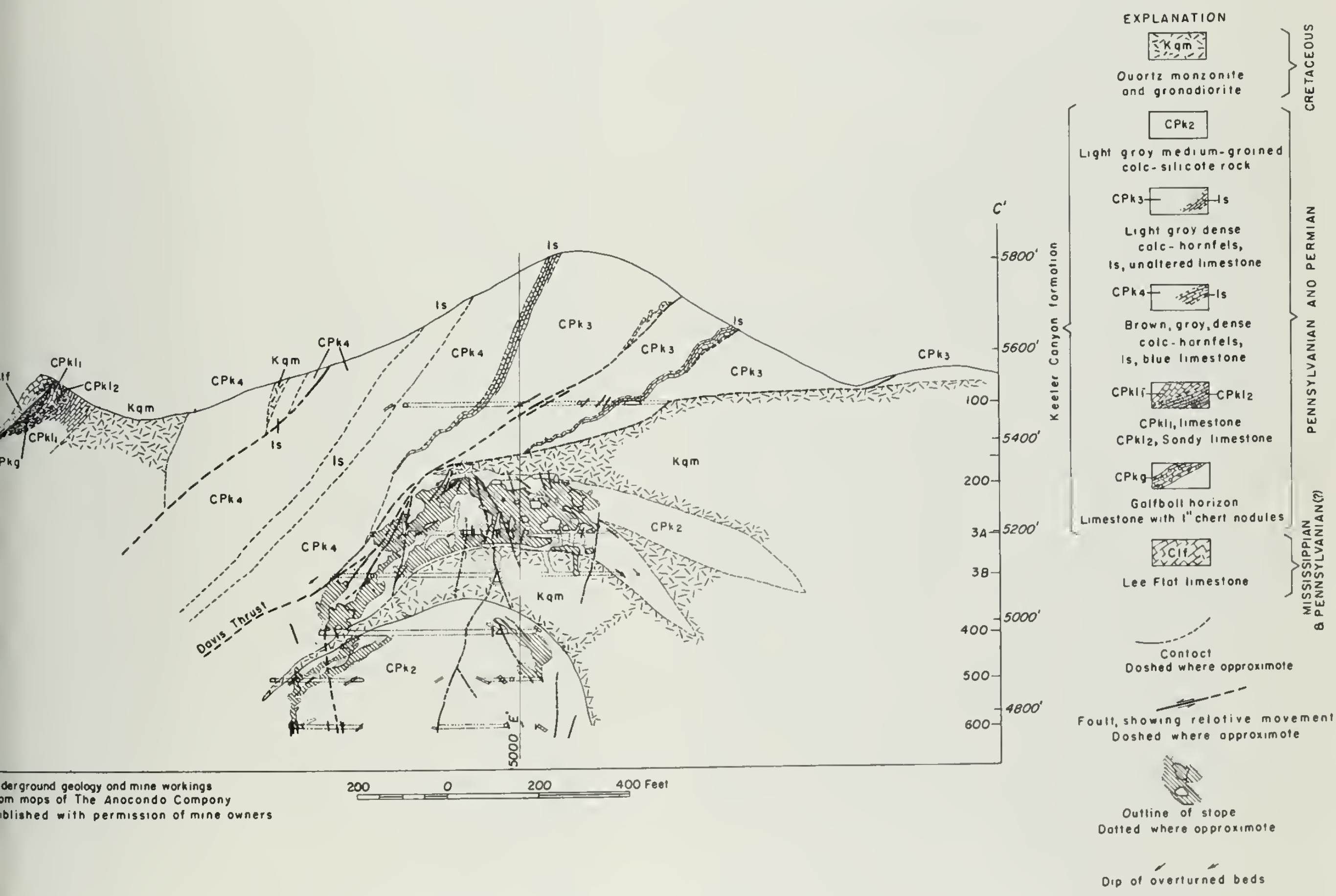


FIGURE 4. Geologic section of the Independence workings showing stope outlines.

The underground workings show that the stock of the Darwin Hills terminates to the west in a series of sills that commonly are anticlinal shaped and pinch out in depth to the west (fig. 4). Ore above the 100-foot level is in medium-grained calc-silicate rock above the uppermost sill and below the Davis thrust. The Davis thrust terminates the favorable calc-hornfels in the workings on both the Independence and 100-foot levels. The ore is an irregular bedded replacement body that has a strike length of 250 feet and a width of 120 feet on the Independence level. Approximately 30 percent of the calc-silicate rock over this area is replaced by ore. The ore is stoped from the 100-foot level to the surface. A sill of quartz monzonite is between the 100- and 200-foot levels.

The largest bedded ore body in the district is between the 200-foot and 3B levels over a lower anticlinal-shaped quartz monzonite sill (fig. 4). Bedded ore has been stoped discontinuously between the quartz monzonite sills, a vertical distance of 160 feet, along the crest of the anticlinal-shaped fold (an inverted syncline) for a maximum strike length of 500 feet on the 3B level. Ore has been mined westward down the dip above the upper contact of the lower sill for a distance of 700 feet to the 400-foot level.

Smaller bedded ore bodies are below the lower sill between the 400-foot and 600-foot levels (fig. 4). All the known ore is within 100 feet of the lower contact of the sill. The ore body on the west limb of the inverted syncline is 200 feet long and as much as 50 feet thick; it has been mined 260 feet down the dip below the 400-foot level. A smaller bedded ore body was mined on the east limb of the inverted syncline from the 400 level to 40 feet below the 500 level.

Rip Van Winkle Workings. The Rip Van Winkle workings are on the west side of the Darwin Hills above the Darwin mine camp. They include the workings on the Water Tank fault, the Mickey Summers fault, and the workings 680 feet N. 40° E. of the portal of the Radiore adit (pl. 5).

The shaft on the Water Tank fault 80 feet east of the water tanks is in calc-hornfels at the intersection of the Water Tank fault with the Davis thrust. The favorable medium-grained calc-silicate rock lies east of the Davis thrust and unfavorable dense, greenish-gray calc-hornfels is west of the thrust. An irregular plug of quartz monzonite crops out at the surface 300 feet northeast of the shaft. The Water Tank fault, which strikes N. 70° E. and dips 85° N., is highly iron stained at the surface.

The Radiore adit crosses the Water Tank fault in the favorable calc-silicate rock on the east side of the Davis thrust, and the fault is mineralized on this level along its strike for 360 feet (pl. 6).

The Mickey Summers fault strikes N. 74° E. and dips 80° SE. A parallel mineralized fault 60 feet north of the Mickey Summers fault is developed by two shafts 220 feet apart. Mineralization is continuous between the two shafts. Kelley (1938, p. 558) reports one of the vertical shafts to be 250 feet deep but inaccessible at the time of his fieldwork. He states the ore is highly pyritic but is reported to be unusually high in silver.

The inclined shaft 680 feet N. 40° E. of the portal of the Radiore adit is on a vein 6 feet thick that strikes N. 20° W. and dips 54° SW. parallel to bedding. The vein, which can be traced for about 50 feet on the surfac[e] in dense white to light-gray calc-hornfels 70 feet [e]t of a small outcrop of quartz monzonite. Only a sm[all] amount of ore minerals is exposed in the Radiore [a]t 218 feet below the collar of the shaft.

Thompson Workings. The Thompson workings 1,200 feet N. 25° W. of the Defiance workings near western contact of the stock of the Darwin Hills. Qua[rtz] monzonite crops out at the portal of the Thompson a[dit] and it extends 370 feet N. 67° W. into the adit and feet on the surface west of the adit. White medi[um]-grained calc-silicate rock is exposed west of the qua[rtz] monzonite and extends over an outcrop width of feet to the Davis thrust. Bedding in the calc-silicate r[ock] strikes north and dips 16° to 53° W. The Copper fa[ult], which strikes N. 60° E. and dips steeply to the north exposed near the portal of the Thompson adit. Two p[ar]allel faults cut the calc-silicate rock 300 and 360 f[eet] north of the Copper fault.

The ore in the Thompson workings is in medi[um]-grained calc-silicate rock in the same stratigraphic ho[ri]zon as in the Independence and Bernon workin[gs]. Gossan 1 foot to 6 feet thick is exposed in a surf[ace] stope in calc-silicate rock at the contact with qua[rtz] monzonite 250 feet S. 75° W. of the Thompson por[tal] and 40 feet north of the Copper fault. Most of the [ore] mined underground was north of the gossan that [is] exposed at the surface, and only minor mineralizat[ion] is exposed on the 200-foot level 77 feet below the surf[ace] stope. The ore underground is in faults striking N. 5[?]- 70° E. in calc-silicate rock close to intrusive conta[cts] and also in fractures in calc-silicate rock closely p[ar]allel to intrusive contacts. The 234 and 229 northea[st]-striking faults are mineralized discontinuously for d[is]tances as much as 400 feet from a minor sill or dike [of] quartz monzonite. Ore has been stoped along the 234 fa[ult] for as much as 190 feet along its strike. The thickness [of] ore ranges between 4 and 20 feet between the 200-f[oot] and 3B levels, a vertical distance of 200 feet. Above t[he] 200-foot level and below the 3B level the ore is in nor[th]-striking faults between the 234 and 229 faults. The 2[29] fault has been less productive than the 234 fault, a[nd] has yielded ore for 135 feet along strike with a thickn[ess] of 10 feet between the 200-foot and 3A levels. A nea[rly] horizontal sill cuts out the ore at the 3B level, but t[he] faults and a little ore continue beneath the sill. In ad[di]tion a considerable tonnage of ore has been mined fr[om] bedded replacement bodies between the 229 and 2[34] faults.

Fairbanks Mine

The Fairbanks mine is 3 miles north of Darwin [in] secs. 1 and 2, T. 19 S., R. 40 E., at an altitude of 5,6[?] feet. The mine is owned by Mrs. Marie Wilson of S[an] Francisco. The workings consist of a shaft, reported [to] be 150 feet deep (Tucker and Sampson, 1938, p. 44[?]) on a strand of the Darwin tear fault, and a number [of] open cuts and shallow shafts.

The host rock is the lower member of the Keeler Ca[n]yon formation and consists of thinly bedded bluish-gr[ay] limestone that is in part altered to calc-hornfels. T[he] Darwin tear fault cuts across the north end of the mi[ne] area. It is a strongly sheared zone 50 to 100 feet wi[de]

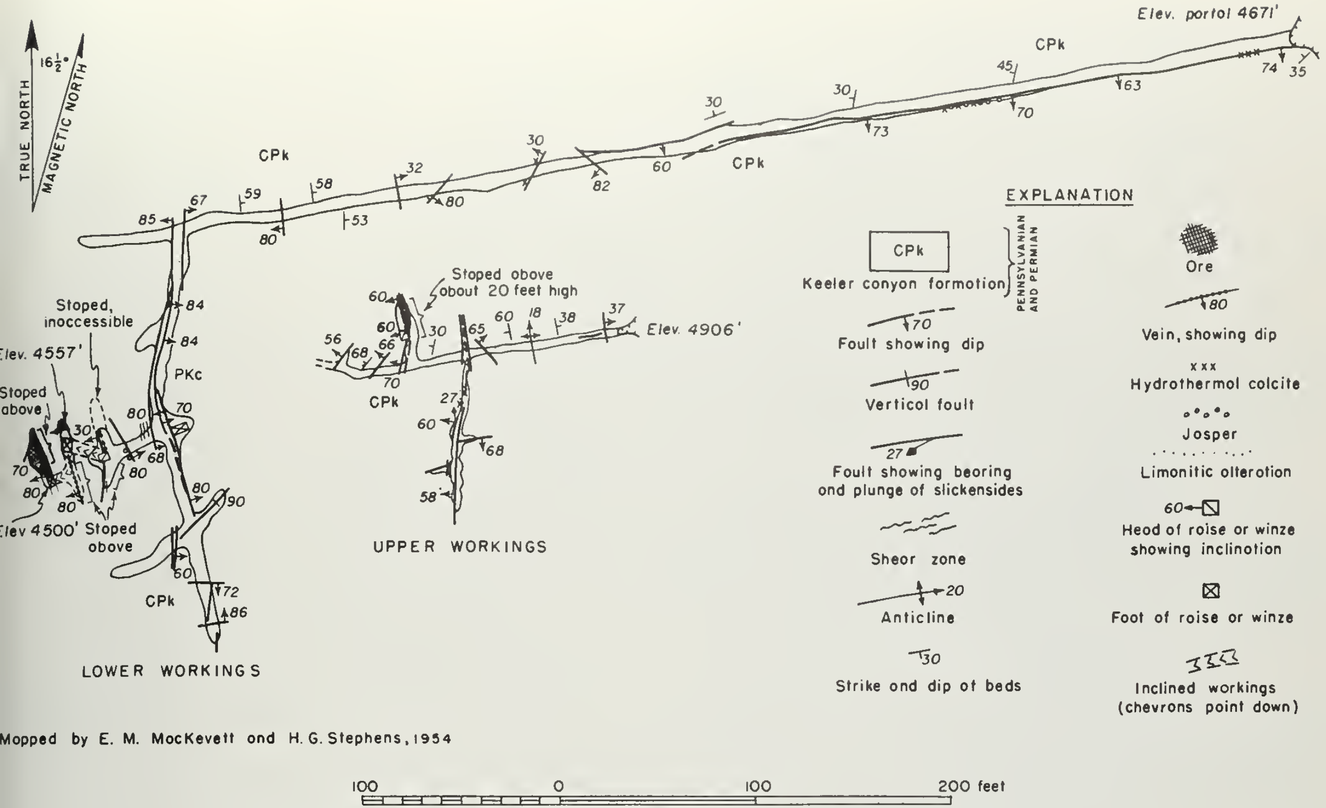


Figure 5. Geologic map of the underground workings of the Keystone mine.

strikes N. 70° W. The Darwin tear fault is highly stained, but apparently contains little or no lead erals. Kelley (1938, p. 554) reports a small chimney e was mined from a vertical vein that strikes north- within the shear zone of the Darwin tear fault. The is 2 to 4 feet thick and consists of galena and ssite in a gangue of calcite and limonite.

ackass Mine

ne Jackass mine is in sec. 18, T. 19 S., R. 41 E., le N. 60° E. of Darwin and half a mile southwest ane mill on the east side of the Darwin Hills at an ude of 5,000 feet. A dirt road 1 mile long extends erly from Darwin to the mine. The property con- of a patented claim owned by George F. Seeman resno, Calif. It is developed by an inclined shaft feet deep with about 150 feet of drifts. An inclined t about 35 feet deep with a short drift at the bottom bout 600 feet N. 15° W. of this shaft.

o record was found of the production from the ass mine. Tucker (1921, p. 288) reports the mine to been in operation at the time of his visit and that ore was carried to the Lane mill by an aerial tram The tram line has since been dismantled. George F. nan acquired control of the property in 1950. He mined 20 tons of ore from workings at the north of the property that he reports assayed 21 percent and 17 ounces of silver per ton (written communi- n, 1955).

ne rocks in the mine area are brown-stained dense hornfels and bluish-gray limestone that is in part ed to tactite. The beds strike N. 20° W. and dip 78° W. The 140-foot inclined shaft is on a bedding-plane vein between a bluish-gray limestone and tactite bed 50 feet thick on the west and brown-stained, dense calc-hornfels on the east. Open cuts at the surface expose the vein with a thickness of 1 to 4 feet over a length of 80 feet. The vein contains some galena and secondary copper minerals in a gangue of limonite and calcite.

On the 66-foot level a drift has been driven S. 38° E. for a distance of 75 feet along the vein and 70 feet N. 18° W. from the shaft. The vein south of the shaft is 1 to 2 feet thick, and ore in the vein is in pockets. The tactite contains a little scheelite disseminated through it over a thickness of 2 to 4 feet several feet into the hanging wall of the vein. North of the shaft a chimney of ore has been stoped for 20 feet along the level to a height of 20 feet and a thickness of 10 feet.

The 35-foot shaft 600 feet N. 15° W. of the main inclined shaft is on a vein that strikes N. 63° E. and dips 77° SE. The vein is 3 feet thick at the surface and contains galena, cerussite, sphalerite, and pyrite in a gangue of calcite and limonite. The vein thins to 1 foot at the bottom of the shaft.

Keystone Mine

The Keystone mine is in secs. 19, 20, 29, and 30, T. 19 S., R. 41 E. It lies mainly on the east slope of the Darwin Hills about 1.75 miles southeast of Darwin. The mine is owned by Hilda Bickley, Helen Gunn, and Jess G. Sutleff of Independence, Calif.

The lower workings (fig. 5) include the Keystone adit 626 feet long, a drift 210 feet long, 120 feet of crosscuts,

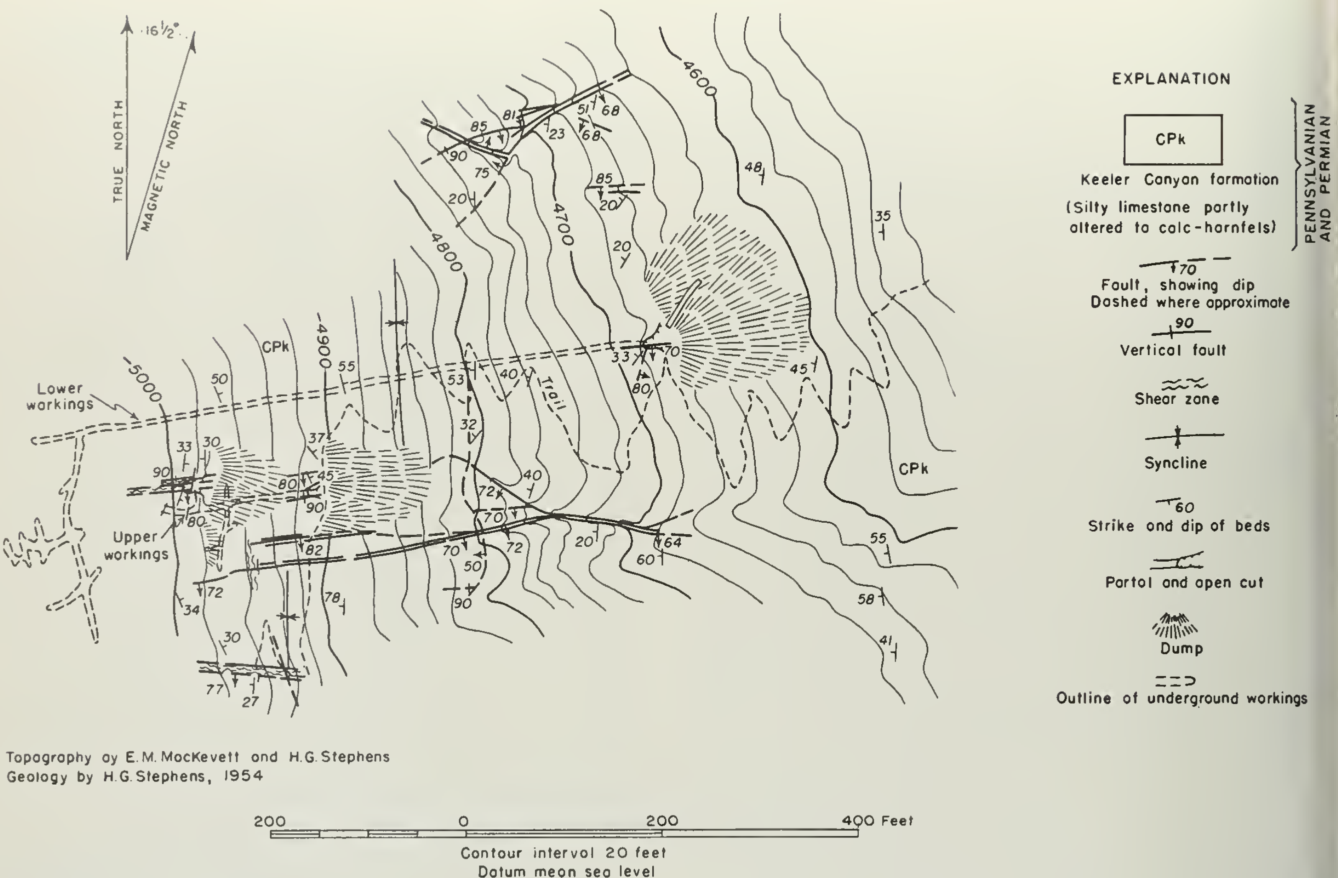


FIGURE 6. Geologic map of the Keystone mine.

a 175-foot steeply inclined winze, and small stopes, The upper workings consist of the McDonald adit, which is caved 145 feet from its portal, 135 feet of drifts, and minor crosscuts. A connecting raise and adjacent stopes between the lower and upper workings are largely inaccessible.

Production data are rather scanty. Tucker and Sampson (1938, p. 435) report that 800 tons of sorted ore was shipped from the lower winze and the zone between the lower and upper workings. This ore contained 15 percent lead, 28 ounces of silver per ton, and minor amounts of gold. Shipments during 1940 and the early part of 1941, according to the records of Mr. Sutleff, consisted of 205 tons of ore containing 0.04 ounces of gold per ton, 27.9 ounces of silver per ton, 25 percent lead, 0.6 percent zinc, and 20 percent iron.*

The mine is in folded and faulted rocks of the upper member of the Keeler Canyon formation (fig. 6). The rocks are brown-weathering silty limestone and blue-gray limestone. The limestones are partly altered to calc-hornfels, particularly in the western part of the mine area. The dominant faults trend between N. 70° E. and east and dip steeply.

Ore is in a poorly exposed vein 2 to 10 feet thick that strikes north and dips 60° W. to vertical. It has been exploited for a strike length of about 40 feet underground. The ore is highly oxidized and contains cerussite as the chief ore mineral with only minor relict galena. Gang minerals are limonite, jasper, and calcite.

* Published with permission of the mine owners.

Lane Mine

The Lane mine is 1.4 miles northeast of Darwin sec. 18, T. 19 S., R. 41 E., on the east side of Darwin Hills at an altitude of 4,440 feet. The mine adjacent to the Lane mill. The road from Darwin Panamint Springs passes through the mill site. The A conda Company owns the property but has not opera it to date.

Development work consists of two vertical shafts feet apart that are 600 and 800 feet deep with lev at 280, 350, 470, 610, and 700 feet according to an dated old company assay map of the mine. Waring a Huguenin (1919, p. 98) report the shafts as 725 a 750 feet deep. Both shafts are inaccessible. Two ot shafts 300 and 600 feet west of the main shaft are e 200 feet deep. An adit reported by Kelley (1938, p. 5 to be 1,300 feet long and now accessible for about 1, feet trends S. 85° W. from the gully just west of shafts.

The mine was discovered early in the history of Darwin district, but was not extensively developed u the early 1890's by the Inyo Mining and Developm Company according to Crawford (1894, p. 24). The m was not mentioned by Goodyear in the Eighth Ann Report of the State Mineralogist for 1888. By 18 Crawford (1894, p. 24) reports shafts 30, 80, and

Table 6. Ore produced from the Lane mine.†‡

ar	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lbs.)	Lead (lbs.)	Operator
1899	--	--	--	--	--	
----	--	796	4,927	--	--	W. W. Boswell
----	--	581	4,167	--	--	W. W. Boswell
----	4	1	207	--	3,200	Inyo County Mining & Dev. Co.
----	2	--	118	2,600	2,042	Inyo County Mining & Dev. Co.
----	20	--	1,176	--	8,772	Inyo County Mining & Dev. Co.
----	41	23	1,756	342	38,016	Silas H. Reynolds
----	120	58	43	--	--	Silas H. Reynolds
----	122	15	6,780	904	83,406	Silas H. Reynolds
----	300	24	3,828	4,938	114,495	Silas H. Reynolds
----	198	34	10,237	2,614	108,377	Silas H. Reynolds
----	20	--	1,387	--	12,511	Theo Peterson
----	31	--	245	--	16,000	Theo Peterson
----	816	1	2,876	3,484	59,214	L. D. Foreman & Co.
----	859	--	4,390	2,237	130,770	L. D. Foreman & Co.
----	1,764	7	10,123	5,215	282,985	L. D. Foreman & Co.
----	769	--	3,250	4,150	137,342	L. D. Foreman & Co.
----	44	1	444	68	30,012	Theo Peterson
----	5,890*	1	15,066	9,298	649,495	L. D. Foreman & Co.
----	334*	--	888	926	51,618	L. D. Foreman & Co.
----	579*	5	3,804	1,962	89,948	L. D. Foreman & Co.
----	31*	--	154	--	2,685	L. D. Foreman & Co.
otal	11,944	1,547	75,866	38,738	1,820,888	

lngs and dumps.
luction figures for 1900 through 1940 furnished by U. S. Bureau of Mines.
lished with the permission of the mine owners.

deep, and by 1896 the main shaft was 500 feet p (Crawford, 1896, p. 32). In 1898 a 25-ton blast nace was built at the mine, but it operated only efly (Waring and Huguenin, 1919, p. 99).

he Darwin Development Company began construc- of a 25-ton mill in 1915 (Waring and Huguenin, 9, p. 98). The mill was rebuilt and enlarged in 1919 was operated intermittently until 1926 when it was uilt to a 200-ton capacity according to Kelley (1938, 53). Ore from the Defiance and Independence work- s and from the Lucky Jim mine was treated at it il 1942 when Imperial Metals built a 150-ton mill at Darwin mining camp to treat the oxide ore.

he recorded production from the Lane mine, which udes the Last Chance (Sorba), Last Chance 2, Last nce 3, Southwest, Major Butt, and Lane Mill claims, ls 11,944 tons of ore from which 75,866 ounces of er and 1,820,888 pounds of lead were recovered. For ain years the Lane mine production was not reported arately but was included in the Darwin group. The duction for 1888 to 1942 was compiled by the U. S. eau of Mines.

he upper member of the Keeler Canyon formation of nsylvanian and Permian age crops out in the mine . The rocks consist of bluish-gray, silty limestone that n part altered to light-gray and greenish-gray calc- nfels and is locally highly iron stained.

he rocks are deformed into gently dipping open folds. axis of a syncline that trends southward just above edge of the alluvium is between the two deeper fts. The rocks are intersected by several faults that ke N. 65°-85° E., and dip steeply; displacement is ll and is of left-lateral sense.

he ore is in a fissure-vein that strikes N. 65°-85° E. l dips steeply north. At the collar of the westernmost ft the shear zone is 12 feet thick and contains gossan and some copper minerals over a width of 30 inches. Crawford (1896, p. 32) reports that the main shaft extends along the vein to a depth of 300 feet and that the ore shoot is 100 feet long and plunges vertically. On the 300-foot level a cross vein is exposed that strikes northwest and averages 4 feet in thickness. The shaft is on this cross vein below the 300-foot level.

The ore is mainly cerussite with small pockets of relict galena in a gangue of calcite, jasper, and minor fluorite. A company assay map shows that some of the ore on the deeper levels locally contains 1 to 2 percent copper.

The long adit west of the main working is along the same shear zone that is in the shafts, but it exposes little lead-silver ore. Locally the shear zone is iron stained and contains pockets of calcite and jasper. Minor scheelite is in the adit between 700 and 800 feet from the portal.

Lucky Jim Mine

The Lucky Jim mine is 2.7 miles N. 3° W. of Darwin in sec. 1, T. 19 S., R. 40 E., at an alitit ude of 5,240 feet. The Anaconda Company owns the property. The mine was formerly one of the major producers in the district. Kelley (1938, p. 553) estimates the value of ore produced at $2,000,000.

Workings (figs. 7, 8) consist of a 320-foot vertical shaft, several shallower shafts, approximately 7,690 feet of level workings distributed among 12 levels, about 1,000 feet of winzes and raises, and large steep stopes. The deepest level is 860 feet below the collar of the main shaft. The Anaconda Company renovated the main shaft and most of the main levels in 1948, but most of the stopes and some of the levels are still inaccessible. A view of the main workings is shown in photo 6.

The mine is in strongly faulted calc-hornfels and quartz monzonite host rocks (fig. 9). The calc-hornfels is correlated with the lower member of Pennsylvanian and Permian Keeler Canyon formation and has been divided into a light unit and a dark unit. The light unit is a light-gray to white, fine-grained, diopside-rich rock with minor quartz and calcite. Its bedding is generally

Photo 6. Lucky Jim mine. The Christmas Gift mine is in the background. The area is underlain by calc-hornfels of the lower member of the Keeler Canyon formation.

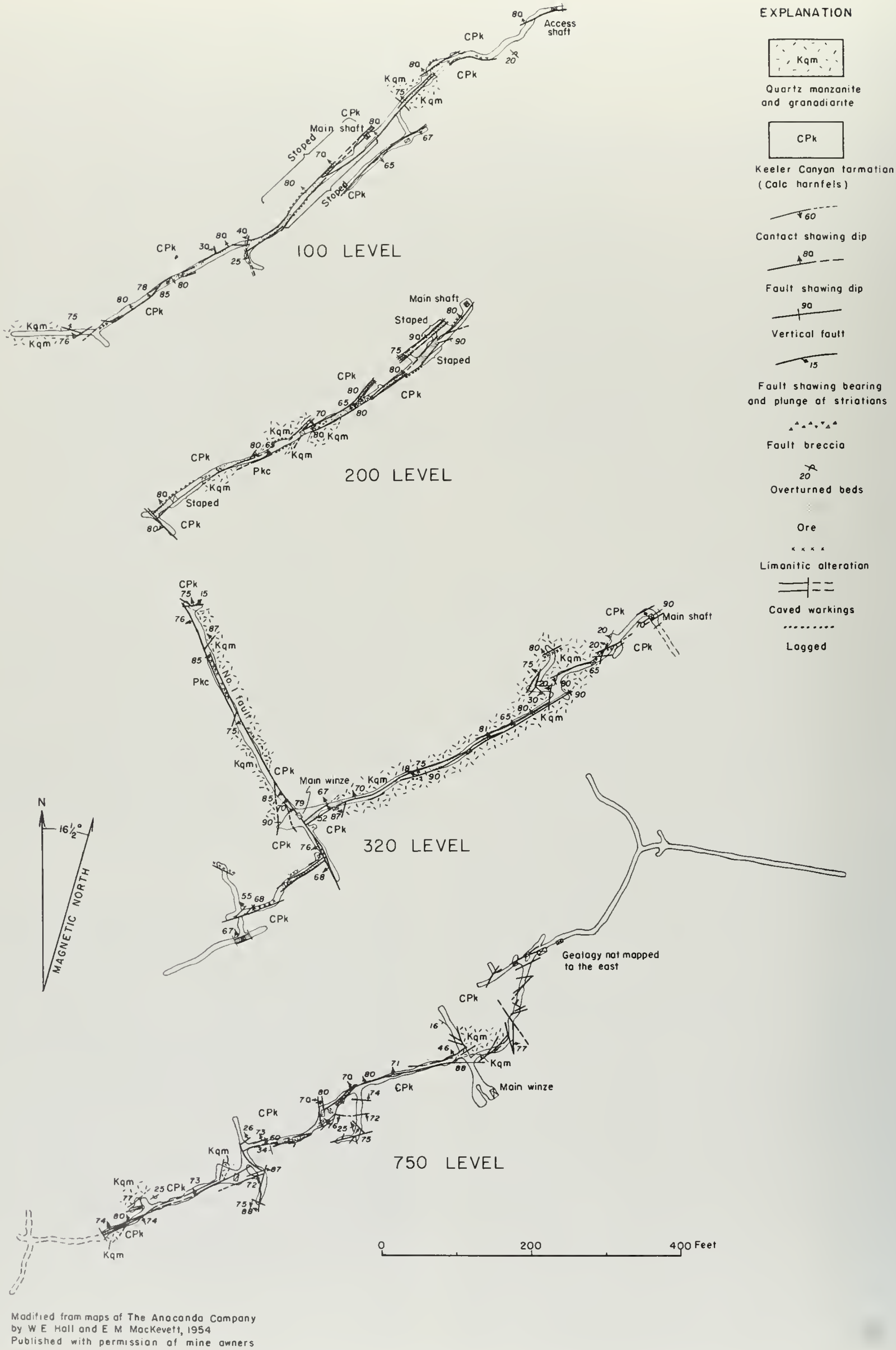


FIGURE 7. Geologic maps of the underground workings of the Lucky Jim mine.

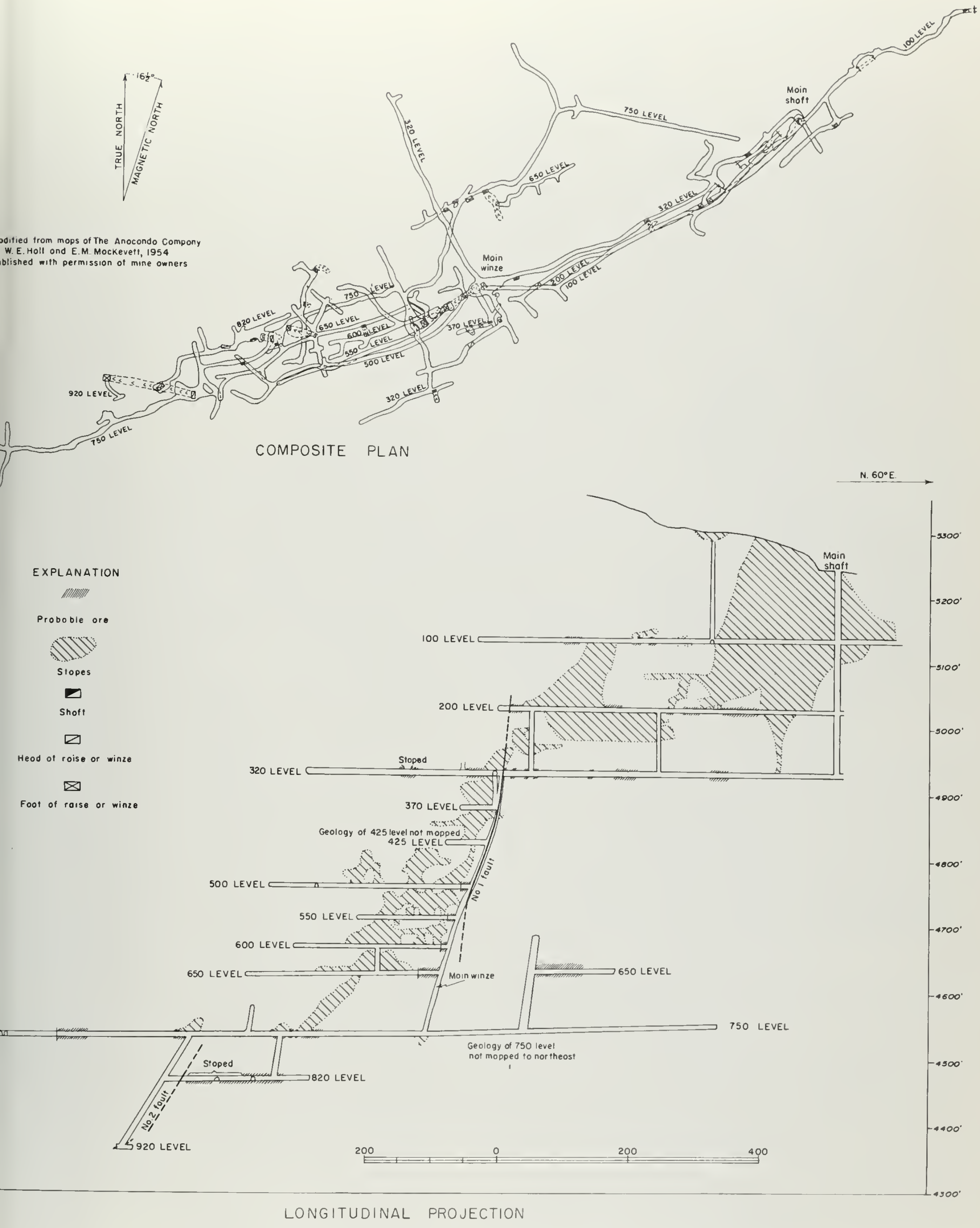


FIGURE 8. Composite map and longitudinal projection of the Lucky Jim Mine.

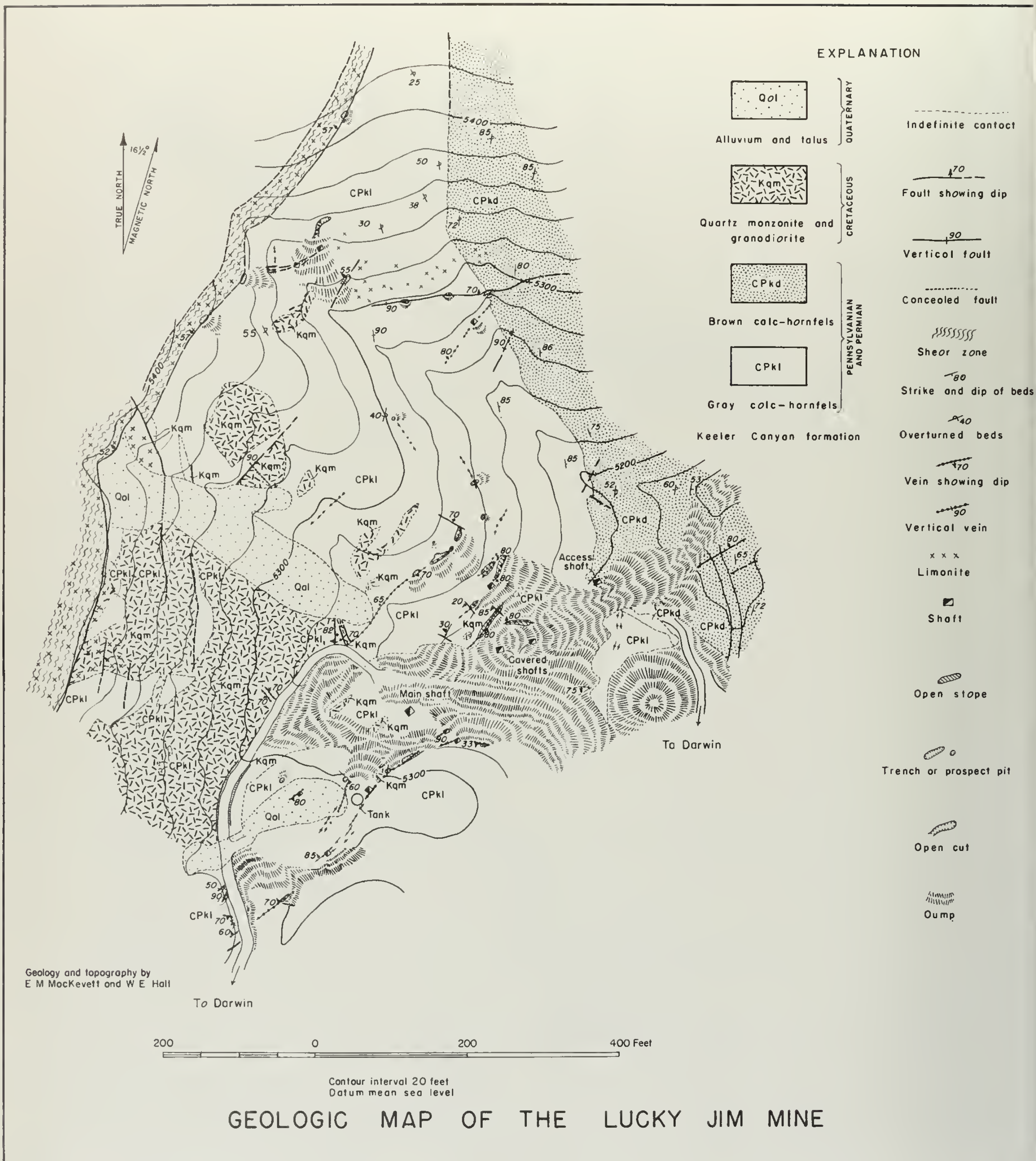


FIGURE 9. Geologic map of the Lucky Jim Mine.

*Table 7. Partial ore production from the Lucky Jim mine.**

; given in report on Darwin Mines by Ira Joralemon (1940) :

Year	Dry tons	Average grade					Metal content		
		Au	Ag	Pb	Zn	Cu	Gold (oz.)	Silver (oz.)	Lead (lbs.)
5-1923 Crude ore	11,592	0.017	36.0	18.0	6.8	0.3	--	--	--
7-1924 Ore milled†	28,848	.009	11.3	10.4	4.0	--	--	--	--
Total	40,440	.011	18.39	12.58	--	--	456.7	743,759	10,178,148

om old records of Darwin Mine and of Lane Mill:

Year		Tons
y 1922-Jan. 1923	Crude ore	210
y 1922-Jan. 1923	Mill ore	8,590‡
. 1923-Jan. 1924	No data	--
. 1924-July 1924	--	34 (probably from dump)

Data furnished by the Anaconda Company.
ncludes dump ore.
ncludes 2,850 tons of dump ore.

oscure, but locally 1- to 2-foot thick beds are discernle. The dark unit conformably overlies the light unit. is light gray on fresh surfaces and weathers to medium rown. The dark unit is a fine-grained calc-hornfels composed mainly of quartz, calcite, and diopside in beds to 2 feet thick. Local lenses of fusulinid-bearing blue mestone 1 to 2 feet thick are in this unit. The quartz onzonite is a greenish-gray, altered porphyritic rock hat crops out as numerous irregularly shaped masses hroughout the mine area and is exposed as dikes and lls in the mine workings.

The metasedimentary sequence strikes northerly and ips west except for minor folds in the eastern part of he mine area and minor divergences in attitude near lutonic salients. Rocks in the mine area are strongly aulted. The major faults and the economically importnt faults, exemplified by those in the Lucky Jim fault one, strike N. 60°-75° E. and except for local diverences dip steeply northwest. The faults of this zone enerally are not traceable for more than 150 feet. They ommonly branch into other faults, which become domiant, or are superseded by en echelon faults (fig. 7). he fault zone ranges from a foot to approximately 20 eet in thickness. Locally faults of the Lucky Jim fault one encompass horses of country rock or splay out into eak faults. Some faults in the Lucky Jim fault zone ave well-developed mullion structures that rake from 8° to 30° SW. Near-vertical slickensides are locally uperposed on the mullion surfaces and indicate later ip-slip movement. The major displacement was strikelip and left lateral. This movement is similar to that n the nearby northwest-trending Darwin tear fault. he number 1 fault, which strikes N. 30° W. and dips teeply southwest, displaces the Lucky Jim fault zone ausing the west segment to be offset about 50 feet to he south. Whether this is a manifestation of dominant trike-slip or of dip-slip movement is not known. The umber 2 fault is similar to the number 1 fault in attiude. The number 2 fault apparently truncates ore on he 820-foot level, but only minor mineralization is exposed on the 920-foot level southwest of the number 2 fault. Very little work has been done southwest of this fault on the deeper levels, where the ore shoot would project, however.

Ore occurs mainly as fissure fillings within the steep northeast-trending Lucky Jim fault zone and is commonly bounded by fault surfaces. Stope outlines (fig. 7) indicate that the bulk of ore was mined between the surface and the 320-foot level northeast of the number 1 fault. Another productive shoot was mined southwest of the number 1 fault between the 320- and 820-foot levels. This shoot may represent a segment of the shoot above the 320-foot level that has been down-faulted by the number 1 fault. The ore shoots are as thick as 15 feet and average about 3 feet; they rake moderately southwest. Much of the Lucky Jim fault zone is tight and lacks vein minerals. The ore shoots appear to be localized where the fault diverges to a more northeasterly strike, similar to an ore control at the Christmas Gift mine. Minor quantities of ore occur in some of the gently dipping fissures.

The ore consists mainly of galena and its oxidation products cerussite and anglesite. Heavy iron staining pervades the veins and masks many of the mineralogic details. Galena occurs as small relicts 2 or 3 inches in diameter surrounded by cerussite and minor anglesite. Secondary copper minerals are present locally. The chief gangue minerals are quartz, calcite, pyrite, and limonite, accompanied by lesser amounts of jasper, fluorite, jarosite, and clay minerals.

Assays by The Anaconda Company show that the metal content of the Lucky Jim vein ranges from less than 1 ounce of silver per ton and 1 percent lead to about 70 ounces of silver per ton and 30 percent lead. The assays show some zinc, but no zinc minerals were identified.

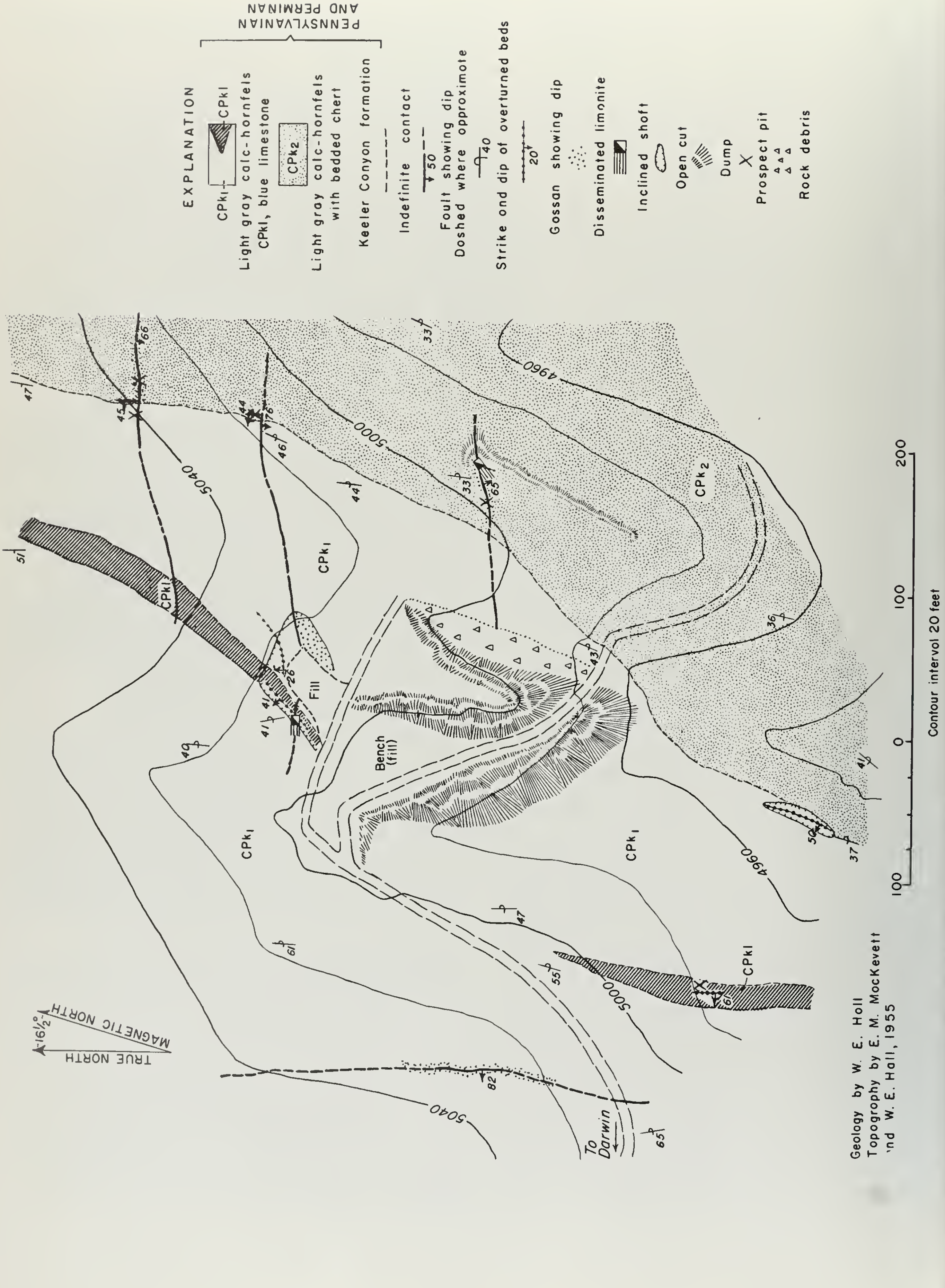
Promontory Mine

The Promontory mine is near the south end of the Darwin Hills 1.3 miles southeast of the town of Darwin in sec. 30, T. 19 S., R. 41 E., at an altitude of 5,000 feet. The property is accessible by a dirt road that leads south from Darwin. The Anaconda Company owns the mine but has not operated it. The property is developed by an inclined shaft with a vertical depth of 283 feet and with levels at depths of 40, 67, 140, 170, 180, 210, 240, and 280 feet. The production from the Promontory mine is not known, as the production in the past gen-

*Table 8. Ore produced from the Promontory mine since 1911.**

Year	Dry tons	Average grade					Metal content		
		Au	Ag	Pb	Zn	Cu	Gold (oz.)	Silver (oz.)	Lead (lbs.)
1911	21	--	--	--	--	--	--	1,116	5,667
1916-1919[2]	1,932[3]	0.086	37.4	21.6	3.0	0.17	--	--	--
1937[2]	87.6[3]	.053	24.0	17.8	5.2	--	--	--	--
Total	2040.6	.08	37.0	21.3	--	--	170	75,571	871,119

* Data supplied by the Anaconda Company, 1956, and published with their permission.
[2] Data from report on Darwin Mines by Ira Joralemon, 1940.
[3] Crude ore.


EXPLANATION
CPkl
Light gray calc-hornfels
CPkl, blue limestone
CPk2
Light gray calc-hornfels with bedded chert
Keeler Canyon formation
PENNSYLVANIAN AND PERMIAN
Indefinite contact
Fault showing dip
Dashed where approximate
Strike and dip of overturned beds
Gossan showing dip
Disseminated limonite
Inclined shaft
Open cut
Dump
Prospect pit
Rock debris
TRUE NORTH
MAGNETIC NORTH
16½°
Contour interval 20 feet
Geology by W. E. Hall
Topography by E. M. MacKevett
and W. E. Hall, 1955
To Darwin
Bench (fill)
Fill
CPk1
CPk2
5040
5000
4960

ally has been reported with that of the Darwin Silver oup.

The average grade of ore that has been shipped is not own. According to records in the San Francisco office the U. S. Bureau of Mines, however, 1,116 ounces silver and 5,667 pounds of lead were recovered from 21-ton shipment of ore in 1911 by C. A. Bradford and 942 ounces of silver and 17,738 pounds of lead were covered from 82 tons of ore shipped in 1918 by the arwin Development Company. The average grade of is ore is 21 ounces of silver per ton and 11.3 percent ad.

The lower member of the Keeler Canyon formation of nnsylvanian and Permian age crops out in the mine area. It consists of light-gray dense calc-hornfels with some relicts of limestone and light-gray dense calc-hornfels with interbedded chert and hornfels. The beds strike northerly and dip 33° to 55° W. in an overturned section. The beds in the mine area are cut by three faults that strike N. 70°-80° E. and dip steeply south and by a fault 240 feet west of the main shaft that strikes northerly and dips 82° W. (fig. 10).

The ore occurs as a bedded replacement of limestone and light-gray calc-hornfels close to faults that trend N. 70° E. Three mineralized beds are exposed in the open cut at the main inclined shaft. The westernmost vein is a replacement of a bluish-gray limestone bed that is exposed in the collar of the shaft. Gossan is also exposed in light-gray calc-hornfels 12 feet and 40 feet farther

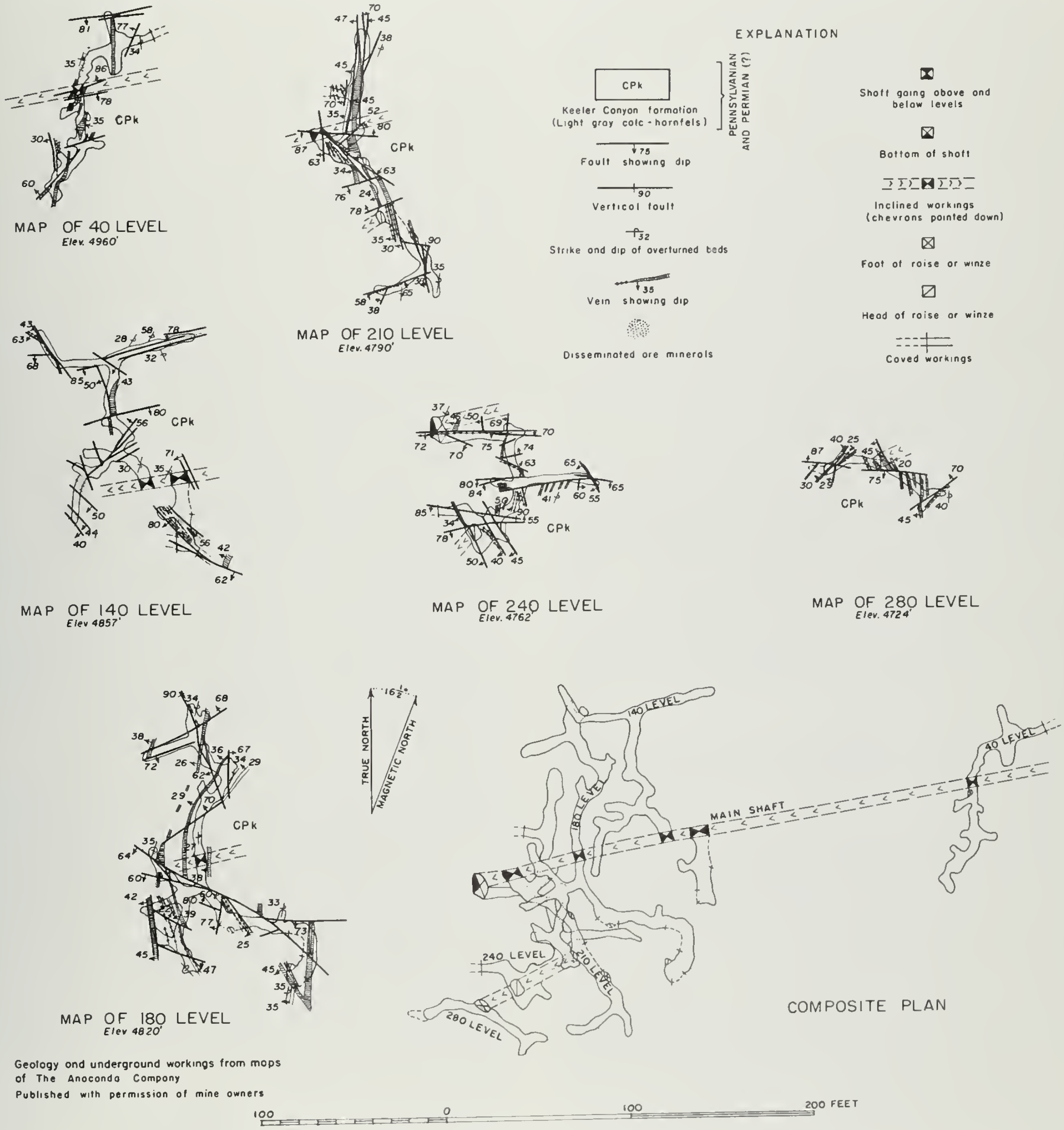


Figure 11. Geologic maps of the underground workings of the Promontory mine.

east of the shaft. The veins can be traced on the surface for only a few feet north of the open cut.

The most extensive ore exposed in the mine is on the 180- and 210-foot levels. On the 180-foot level ore is exposed discontinuously for 180 feet as a replacement of 3 or 4 thin beds (fig. 11). The veins range from a few inches to 5 feet thick. On the 210-foot level one vein is exposed for 133 feet that ranges in thickness from a few inches to 8 feet. Mineralization below the 210-foot level is weak.

Gossan is exposed in several shallow workings south and southeast of the main inclined shaft. A shallow surface stope 52 feet long, 350 feet S. 10° W. of the inclined shaft exposes gossan 2 to 4 feet thick parallel to bedding and a shallow inclined shaft has been sunk on gossan 210 feet S. 54° E. of the main inclined shaft.

The ore consists of cerussite and minor wulfenite, plumbojarosite, and hydrozincite in a gangue of jasper, iron oxides, and calcite. Kelley (1938, p. 561) reports some siderite in the gangue also.

Santa Ana Mine

The Santa Ana mine is in sec. 18, T. 19 S., R. 41 E., on the east slope of the Darwin Hills at an altitude of 4,560 feet. According to claim notices the mine was located by L. D. Owen in July 1926, sold to Alex Ruona in February 1927, and subsequently deeded to the present owners, Hilma Ruona of Huortana, Finland, and Marie Ruona Wilson, of San Francisco. According to Kelley (1938, p. 559) the mine probably was worked during the nineties. The main workings consist of a 200-foot vertical shaft with drifts at the 75-, 150-, and 200-foot levels and with a 30-foot winze from the lowest drift. Other workings are an inclined shaft about 30 feet deep and shallow surface pits.

The country rock is blue limestone and greenish-gray, brown-weathering calc-hornfels of the upper member of the Keeler Canyon formation. The main workings are on a vein striking N. 42° E. and dipping 85° SE. The vein ranges from 1 foot to 6 feet in thickness at the surface, and Kelley (1938, p. 559) states it is as much as 10 feet thick where exposed in underground workings. The vein is highly iron stained and contains jasper and coarse gray calcite. Galena and cerussite are the chief ore minerals.

Standard Group

The Standard Group includes several claims in the eastern part of sec. 13, T. 19 S., R. 40 E., and in the western part of sec. 18, T. 19 S., R. 41 E. The claims were explored and mined mainly during the early 1920's by Alex Ruona. They are now owned by Mrs. Marie Wilson of San Francisco and Hilma Ruona of Finland. A small mine camp in the canyon north of Lane Canyon was largely demolished by a cloudburst. The mine workings consist of many adits and open cuts. No record of production was found.

Workings of the Standard Group are near the irregular eastern border of the stock of the Darwin Hills, mainly in calc-hornfels of the Keeler Canyon formation, but locally within granitic rocks. Bedding strikes north and dips mainly west except for minor open folds, one of which is well exposed near the old mining camp. Two nearly vertical branches of a N. 60°-80° W.-trending fault zone near the old campsite are the most conspicu[ous] structural features. These faults, which are parallel [to] the Darwin tear fault, are marked by iron-stained bre[ccia] and gouge zones 10 to 40 feet thick with pockets [of] jasper, calcite, and minor pyrite, chalcopyrite, and [ga]lena. These faults have been extensively explored by ad[its], but little ore has been found. The ore-bearing vei[ns], which are 1 foot to 4 feet thick, strike N. 50°-75° E. a[nd] dip from 70° NW. to vertical. The most important [of] these are the Standard vein, the Standard Extens[ion] vein, and an unnamed vein, possibly a faulted segm[ent] of the Standard vein, north of the northwest-trend[ing] fault zone.

The Standard vein is exposed for about 1,000 feet [in] the northeast part of sec. 13. Workings on the vein c[on]sist of a vertical shaft 70 feet deep, adits 100 and 2[..] feet long, and extensive surface workings. The v[ein] strikes N. 50°-55° E. and dips from 75° NW. to vertic[al]. Ore is in four closely spaced, thin parallel veins t[hat] contain pockets of galena, cerussite, pyrite, chrysoco[lla], and anglesite in a gangue of highly iron-stained qua[rtz], jasper, and fluorite.

The Standard Extension vein crops out for about 6[..] feet in secs. 13 and 18, about 600 feet south of the Sta[nd]ard vein. Workings on the vein consist of three shaf[ts] each about 100 feet deep, two adits, drifts, and mi[nor] surface workings. The vein strikes N. 60°-70° E. a[nd] dips from 75° NW. to vertical. A salient of the st[ock] of the Darwin Hills is adjacent to the western extre[mi]ties of the vein. Away from the stock the vein cuts ca[lc-]hornfels of the Keeler Canyon formation. The vein av[er]ages about 2 feet in thickness and is composed of coa[rse] calcite, quartz, jasper, and limonite with lesser amou[nts] of galena, cerussite, hemimorphite, and chrysocolla.

A possible faulted segment of the Standard vein cro[ps] out near the extreme northeast corner of sec. 13 nor[th] of a strong northwesterly trending fault. This vein [is] explored by a northeast-trending adit and by surfa[ce] workings. The vein, which is 2 feet thick, strikes N. 6[..] E. and dips 75° NW. It is similar to the Standard ve[in] in mineral content.

The strong northwest-trending faults in the mi[ne] area are explored by long adits, but apparently th[ey] lack ore. Small quantities of ore minerals are local[ly] distributed on steep minor subsidiary faults that stri[ke] between N. 25° W. and N. 25° E.

Susquehanna Mine

The Susquehanna mine is in sec. 24, T. 19 S., R. 40 E[.], between The Anaconda Company mining camp and Da[r]win at an altitude of 4,880 feet. The property is own[ed] by the Mickey Summers' estate, and it is leased to Ro[..] Finley and Tom Vignich of Darwin. The mine is acce[s]sible by hard-surfaced roads both from Darwin a[nd] from The Anaconda Company mining camp. It is dev[el]oped by an inclined shaft 43 feet deep that bears S. 2[..] E. at −79°. A drift at the bottom of the shaft heads [..] 50°-70° E. for approximately 870 feet with a few sho[rt] crosscuts from it. Little stoping was done. Local re[si]dents state the mine has had a small production, but [no] record of it was found.

The lower member of the Keeler Canyon formation [of] Pennsylvanian and Permian age crops out in the mi[ne] area. The rocks near the collar of the shaft consist [of] anitic light-gray and greenish-gray calc-hornfels. The vis thrust fault is exposed about 300 feet east of the ft. East of the Davis thrust and extending to the k of the Darwin Hills, 800 feet east of the shaft, the ks are aphanitic white and light-gray calc-hornfels. calc-hornfels east of the Davis thrust is cut by a tical fault that strikes N. 50° E. A bedding-plane cture can be traced for about 100 feet north of the 50° E. fault.

oth the N. 50° E. fault and a bedding-plane fracture feet northeast of the shaft are mineralized locally. N. 50° E. fault is iron stained and locally contains or amounts of malachite through a thickness of 8 . A vertical shaft 30 feet deep on the fault exposes ore. The bedding-plane fracture is limonite stained ough a thickness of 3 feet and contains minor jasper. inclined shaft bearing S. 70° W. at minus 33° exes no ore.

he Davis thrust fault is exposed in the underground kings about 300 feet northeast of the main inclined ft. On the east side of the thrust fault, the drift is g a fault that strikes N. 50° E. and dips 50° SE. the intersection of the two faults the sheared calcnfels is highly iron stained and is reported to have tained some ore. The N. 50° E. fault away from the rsection is only slightly mineralized.

Wonder Mine

he Wonder mine is in sec. 18, T. 19 S., R. 41 E., on south side of Lane Canyon 3,000 feet west of Lane l at an altitude of 4,720 feet. The Wonder No. 1 m is on the north side of Lane Canyon adjacent on north to the Wonder claim. The Anaconda Comy owns the property, which has been idle for many rs. The mine was first described by Knopf (1914, 6) and briefly by Kelley (1938, p. 559).

he Wonder claim is developed by an adit about 100 long trending S. 20° E., an inaccessible inclined ft reported by Tucker (1926, p. 465) to be 100 feet p, and several surface pits. The Wonder No. 1 claim eveloped by an inclined shaft, reported by Tucker 26, p. 465) to be 225 feet deep.

he rocks in the mine area are calc-hornfels and lly tactite at the top of the lower member of the ler Canyon formation. Between the workings on the nder and Wonder No. 1 claims the rocks are intered by a number of N. 70° E. fractures that are part the Lane fault. Bedding south of the Lane fault kes north and dips 55° W. North of the fault the kings are along the crest of an open anticlinal-shaped l that may be an inverted syncline.

he ore in the Wonder claim is along a vein that kes N. 27° W. and dips 55° SW. A steep N. 70° E.-nding fault cuts the vein in the adit about 60 feet n the portal and offsets the southern segment apximately 8 feet to the west. The vein is 2 to 6 feet k and consists predominantly of coarse gray calcite, onite, and garnet with local pockets of galena, cerus-, fluorite, pyrite, quartz, oxidized copper minerals, minor scheelite.

imilar ore is exposed along the crest of an anticlinalped fold at the collar of the inclined shaft on the nder No. 1 claim. The ore extends down the west limb of the fold as a bedding-plane vein 4 to 6 feet thick that strikes N. 10° W. and dips 55° SW.

Mines and Prospects in the Argus Range

Darwin Zinc Prospect

The Darwin Zinc prospect is in sec. 2, T. 19 S., R. 41 E., on the west slope of the Argus Range at altitudes of about 3,700 feet. Workings include a crosscut adit 174 feet long trending N. 74° E., a 20-foot raise from the adit, and northwest-trending surface pits and trenches on the slope above the adit. An ore chute about 120 feet long connects the surface workings with the access road near the portal of the adit. Additional older workings are accessible from the canyon north of the new workings and consist of a S. 15° W.-trending open stope 70 feet long and an 87-foot long adit that trends S. 12° W. The portal of a caved north-trending adit is on the north wall of the canyon.

The workings explore a major N. 10°-30° W.-trending fault zone that is marked by numerous fault surfaces and steep parallel brecciated and shattered zones. Fossiliferous silty limestone of the lower member of the Owens Valley formation of Permian age is west of the fault and Mississippian marble lies to the east. The marble appears identical to much of the marble at the Empress and Zinc Hill mines. Minor amounts of hydrozincite in the open stope constitute the only identified ore mineral. Iron staining is locally abundant throughout the fault zone, and in places coarse calcite crystals coat some of the brecciated rock.

Empress Mine

The Empress mine includes four unpatented claims in sec. 2, T. 19 S., R. 41 E., on a precipitous west slope of the Argus Range at altitudes about 4,500 feet (pl. 1). The mine is connected to the Darwin Canyon road by a steep narrow road about 1.2 miles long. The property is operated by W. E. McCulley of Darwin, Calif. The mine production, which is from records of the U. S. Bureau of Mines, is given in the following table.

*Table 9. Ore produced from the Empress mine.**

Year	Crude Ore (tons)	Gold (oz)	Silver (oz)	Copper (lbs)	Lead (lbs)	Zinc (lbs)
1946	79	1	530	2,033	34,891	12,539
1947	89	2	1,450	2,453	66,403	8,141
1948	136	2	2,824	5,880	62,354	22,300
1949	91	1	726	3,699	39,329	12,388
1950	None recorded					
1951	25	--	170	199	13,209	1,670
	420	6	5,700	14,264	216,186	57,038

* Production figures furnished by the U. S. Bureau of Mines and published with the permission of the owner.

Mine workings consist of 412 feet of level workings, less than 100 feet of winzes and raises, small stopes, and minor surface pits and trenches (fig. 12).

The Empress mine is in an unfaulted block of Cretaceous quartz monzonite and a roof pendant of Mississippian limestone that is cut by minor quartz diorite, aplite, and basalt dikes (fig. 13). The limestone beds are 1 foot to 2 feet thick and contain numerous 1- to 4-inch thick chert lenses. The limestone is similar to the

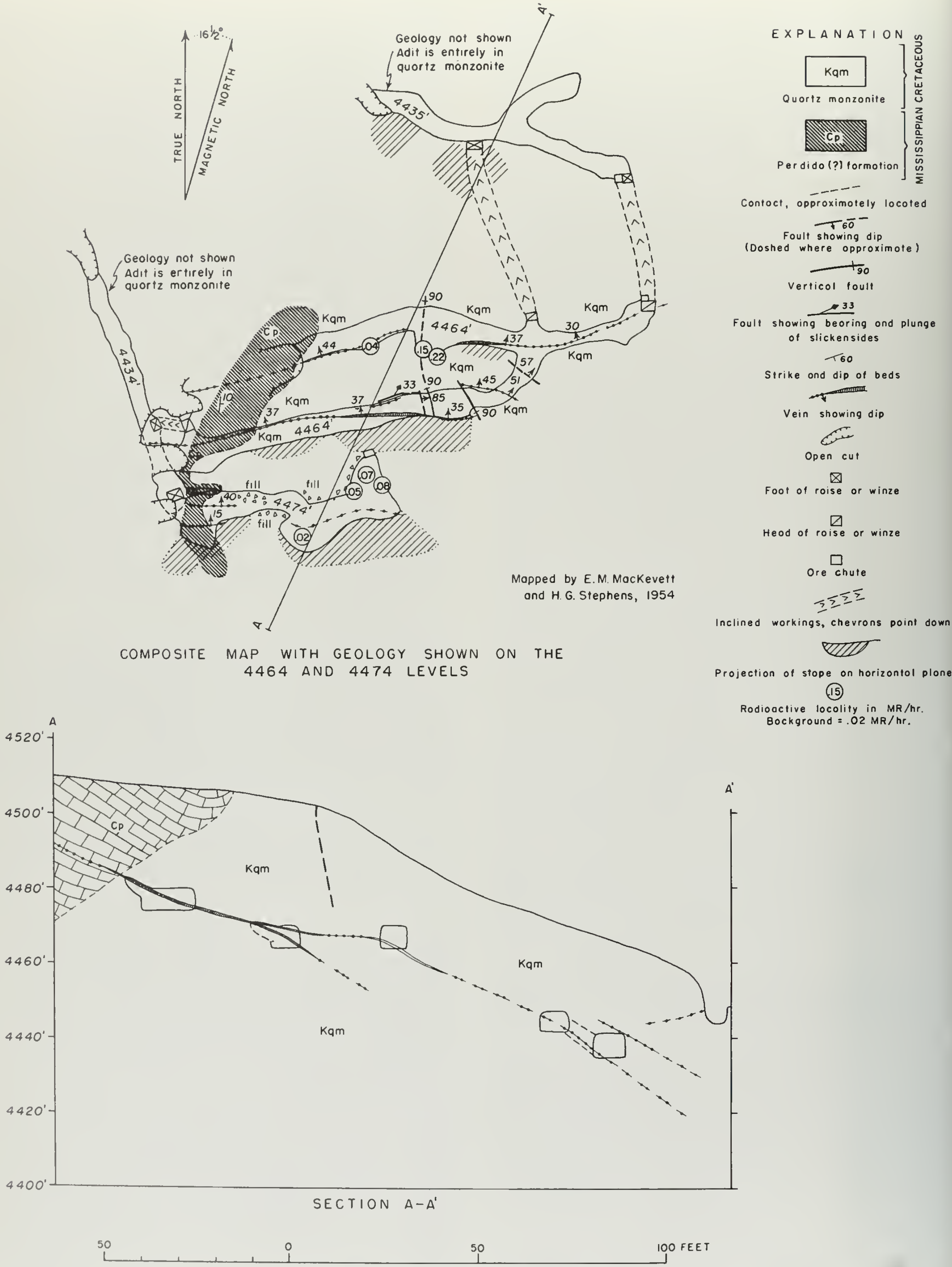


FIGURE 12. Cross section and geologic map of the underground workings of the Empress mine.

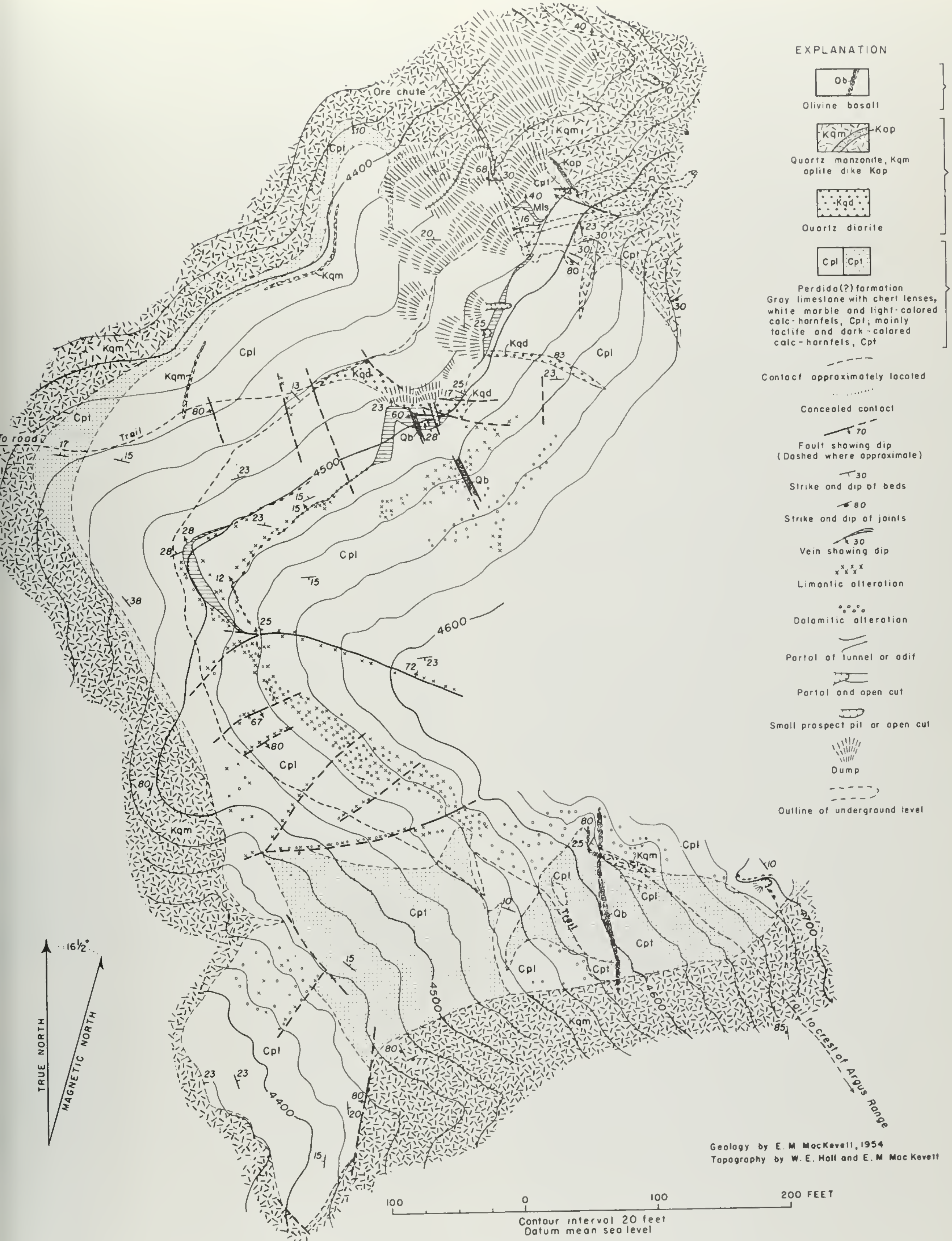


FIGURE 13. Geologic Map of the Empress mine.

Perdido formation of Mississippian age and is tentatively correlated with it. Where unaltered, the limestone is medium gray and the chert is light gray. Most of the limestone is metamorphosed to white marble, light-colored calc-hornfels, and dark-brown tactite; the chert is bleached white. The marble consists predominantly of coarse-grained white calcite, but locally it contains minor amounts of antigorite. Wollastonite is the predominant mineral in the light-colored calc-hornfels. The dark-brown tactite, which attains a maximum thickness of about 70 feet, is generally contiguous to quartz monzonite. It consists of garnet and epidote with lesser amounts of quartz, calcite, pyroxene, limonite, antigorite, and very minor amounts of scheelite and chrysotile.

The quartz monzonite is a medium-grained, pinkish-gray rock containing quartz, orthoclase, oligoclase, and biotite with minor amounts of pyrite, apatite, and sphene. The quartz diorite is a fine-grained, dark-gray speckled rock made up of hornblende, biotite, quartz, and plagioclase with a lesser quantity of apatite and opaque minerals. It occurs in irregular dikelike masses as much as 20 feet thick that are cut by a few aplite dikes 1 inch to 4 inches thick. An altered, grayish-brown basalt dike 3 to 4 feet thick strikes N. 20° W. across the mine area. The dike is intermittently exposed, as its upper limits only locally reach the present erosion surface. The dike consists predominantly of labradorite and olivine. Secondary minerals are calcite, limonite, chlorite, epidote, and iddingsite. Dolomitic alteration of limestone and iron staining are abundant in or near the ore horizon and adjacent to some faults.

Three sets of steep faults cut the rocks in the mine area. These faults strike N. 20°-30° W., N. 70°-80° W., and N. 50°-60° E. Most of the faults can be traced for only short distances. They have little displacement and appear to be closely associated with ore deposition. The ore horizon cuts across some of the faults, but in others the faults displace the ore horizon slightly, a probable attribute to minor movement on the faults after ore deposition.

Bedding mainly strikes nearly east and dips 15° to 40° N. Aberrant southerly dips are near intrusive contacts and in a minor flexure in the east-central part of the mine area.

Ore at the Empress mine is a bedded replacement of limestone and a continuation as a flat-lying quartz vein in quartz monzonite. The ore zone in limestone is well exposed on the surface for about 400 feet where it ranges from a few inches to about 6 feet thick. In places local bifurcations give rise to two separate and generally thinner veins. Extensive iron stains and some dolomite mark the ore horizon in limestone. Most of the early workings exploited the north end of the vein within quartz monzonite near the contact with the limestone. The ore in the southern part of the mine is lower grade and consists of thin discontinuous galena-bearing stringers in a heavily iron-stained and dolomitized host rock. Both limestone and chert of the host rock were replaced by ore.

The primary ore consists of pockets of argentiferous galena, sphalerite, and chalcopyrite in a quartz-rich gangue. Secondary ore minerals are cerussite, anglesite, azurite, malachite, chrysocolla, hemimorphite, and very little wulfenite. The gangue consists mainly of quartz and chalcedony with lesser calcite, limonite, py[illegible] kaolinite, and gypsum. The same minerals are in [illegible] quartz veins that cut quartz monzonite, and the [illegible] minerals generally occur as irregular replacement[illegible] the veins.

Anomalous radioactivity was measured in the [illegible] workings. Local radioactivity ranged from 0.04 to [illegible] MR/hr in the A-15 and A-17 workings; the backgro[illegible] count averaged 0.02 MR/hr (fig. 12). In the A-14 w[illegible]ings radioactivity averaged about 0.03 MR/hr. [illegible] source of the radioactivity is not known.

Wynog Prospect

The Wynog prospect is in sec. 11, T. 19 S., R. 41 [illegible] at an altitude of about 4,080 feet on the west slop[illegible] the Argus Range. The prospect is 2,000 feet S. 18° [illegible] of the Empress mine. It is accessible by a trail 1,000 [illegible] long from the sharp bend in the road to the Emp[illegible] mine. According to claim notices W. W. Tice and [illegible] Quinn of Darwin located the prospect on March 26, 1[illegible] No production has been recorded, and the prospec[illegible] currently idle. The main workings consist of a 50-[illegible] adit trending N. 15° W., a 44-foot drift trending no[illegible]east, and a surface trench 500 feet long about 110 [illegible] N. 60° E. of the portal.

The prospect is in an upfaulted area underlain [illegible] marble and tactite metamorphosed from Mississipp[illegible] limestone and by irregular salients of biotite-qua[illegible] monzonite. Garnet and epidote are the most abund[illegible] constituents of the tactite.

Ore is in a quartz vein 1 inch to 12 inches thick t[illegible] strikes northeast and dips about 35° SE. The host r[illegible] in the main workings is marble. The vein cuts the qua[illegible] monzonite where explored by the trench, and it [illegible]parently pinches out in the intrusive rock north of [illegible] trench.

Three nearly vertical faults trending N. 20° W. [illegible] the vein and each elevates the east side 1 foot to 6 f[illegible] relative to the west side. The vein is truncated by [illegible] southernmost of these faults about 10 feet south of [illegible] portal of the main workings.

The ore minerals include galena, cerussite, chrysocol[illegible] and minor quantities of chalcopyrite, cuprite, and a[illegible]rite. Quartz is the dominant gangue mineral associa[illegible] with minor calcite, barite, hematite, and limonite. T[illegible] ore minerals are in small pods an inch or two long t[illegible] are irregularly distributed in the quartz vein. Parts [illegible] the vein are slightly radioactive and have about tw[illegible] the background count.

Zinc Hill Mine (Utacala Group, Colorado Group)

The Zinc Hill mine is 5¾ miles northeast of Darwin [illegible] sec. 2, T. 19 S., R. 41 E., at the north end of the Arg[illegible] Range at an altitude of 3,875 feet. The mill site a[illegible] abandoned mining camp is on the old State Highway [illegible] between Darwin and Panamint Springs. The mine [illegible] accessible by a pack trail 4,400 feet long that leads nor[illegible]east from the mill site. A small jeep can negotiate t[illegible] trail.

The property consists of five unpatented claims own[illegible] by the Combined Metals Reduction Company of S[illegible] Lake City, Utah. The early history of the mine is inco[illegible]pletely known. The mine was not mentioned by Wari[illegible] and Huguenin in the 15th Annual Report of the Sta[illegible] ralogist for the years 1915-1916. From 1917 to 1920 nine was owned by the Utacala Exploration Com- of Salt Lake City, Utah, during which time it was major zinc producer in California. The property operated by the Combined Metals Reduction Com- from 1941 to 1943 and in 1946, and it was leased oyal J. Wright and Tom Taylor from January to l 1947 and January to May 1949 (Norman and art, 1951, p. 83). The property has been idle since

e known production from the Zinc Hill mine totals .9 tons, of which 2,959.8 tons was oxide ore and .1 tons was sulfide ore. All the ore produced before was oxide ore from the lower mine workings. This veraged 44.18 percent zinc. The production since has been from the upper workings and has been ly sulfide ore. The sulfide ore shipped averaged percent zinc, 1.33 percent lead, and 1.43 ounces per f silver.

*10. Ore produced and grade of ore from the Zinc Hill mine.**

ear	Oxide ore		Silver (oz/ton)	Gross Value
	Tons	Zinc (percent)		
-------	100.7	39.02	1.82	--
-------	1,150	45.2	--	$50,375.90
-------	293.3	49.7	--	13,479.78
-------	667.8	50.1	--	33,413.17
-------	103.9	40.2	--	--
-------	243.1	30.94	--	7,309.09
-------	109.3	39.37	--	2,683.85
-------	250.8	37.32	--	--
-------	40.9	34.45	--	--
tal-----	2,959.8	--	--	--
g.------	--	44.18	--	--

Year	Sulfide ore		Lead (percent)	Silver (oz/ton)	Gold (oz/ton)
	Tons	Zinc (percent)			
------------	385.8	25.47	1.38	1.74	0.01
------------	1,433.2	21.71	1.18	1.3.	0.007
------------	104.9	18.47	2.58	2.08	0.003
------------	40.2	21.76	3.15	1.60	0.005
tal----------	1,964.1	--	--	--	--
g.-----------	--	22.28	1.33	1.43	--
	Undifferentiated ore				
------------	22	27.4	35.7	--	--

hed with the permission of Combined Metals Reduction Co. Data from Company

e property is developed by numerous open cuts, surface stopes, and short adits into a steep hillside. workings develop four separate mineralized areas, here are no interconnecting workings between them. are designated workings A, B, C, and D, for con- nce in writing. The ore from the westernmost work- was brought up to the end of the pack trail by an inclined tramway, and that from the upper workings was brought down by an aerial tram line.

The rocks in the mine area are marble and limestone of Mississippian age faulted against silty limestone of Permian age (fig. 14). The sequence of rocks is given below:

Age	Stratographic unit	Lithology	
Cretaceous(?)		6. Diorite dike	
Permian	Owens Valley formation	5. Silty blue-gray limestone	
Fault	contact		
Pennsylvanian(?) and Mississippian	Lee Flat(?) limestone	4. Marble, white	130+
		3. Blue-gray limestone with bedded chert	130
Mississippian	Perdido(?) formation	2. Ore horizon. Marble. Contains bedded chert in lower part.	200
Mississippian	Tin Mountain(?) limestone	1. Blue-gray limestone, in part altered to marble. Contains bedded chert near top. Lower part probably Tin Mountain limestone.	120+

The oldest rock in the mine area is thinly bedded blue-gray limestone that is locally bleached and recrystallized to marble. It is overlain by a 200-foot-thick marble bed that contains all the known ore bodies. Most of the mineralization is in the upper half of this ore horizon. It is overlain by 130 feet of gray to bluish-gray limestone with 1- to 4-inch-thick beds of chert, which in turn is overlain by marble. The above units lithogically resemble the Mississippian formations found elsewhere in the quadrangle, and Hopper (1947, p. 409) found Mississippian fossils in limestone that is probably about the same stratigraphic horizon 4 miles to the southeast. The lithology is similar to that of the Lee Flat limestone, Perdido formation, and Tin Mountain limestone.

The Mississippian limestones are faulted on both the east and west sides of the mine area against silty bluish-gray limestone of the Owens Valley formation of Permian age.

A fine-grained diorite dike 1 foot to 2 feet thick cuts the Mississippian rocks in the southern part of the mine area. It strikes N. 65° W. and dips vertically. The dike has been stoped at the surface for 250 feet along strike, but the nature of the ore removed is not known.

Faulting is the main structural feature in the mine area. The mine is in a horst of Mississippian limestone that has been faulted up against the Owens Valley formation by steep north to N. 20° W.-trending faults. Beds within the horst strike northwest to west and dip 10° to 38° N.; those in the Permian limestone strike northeast to east and dip 35° to 80° N.

The Zinc Hill fault bounds the horst of Mississippian limestone on the west and has a stratigraphic throw of over 2,700 feet. It is displaced 150 feet, north side west, by 3 northwest-trending faults that are locally dolomitized. Many discontinuous north- to northeast-trending faults are near the ore bodies. They are important in localizing ore bodies, although they have only a few feet of displacement. A major fault striking N. 20° W. bounds the horst on the east. It also has a stratigraphic throw of over 2,700 feet.

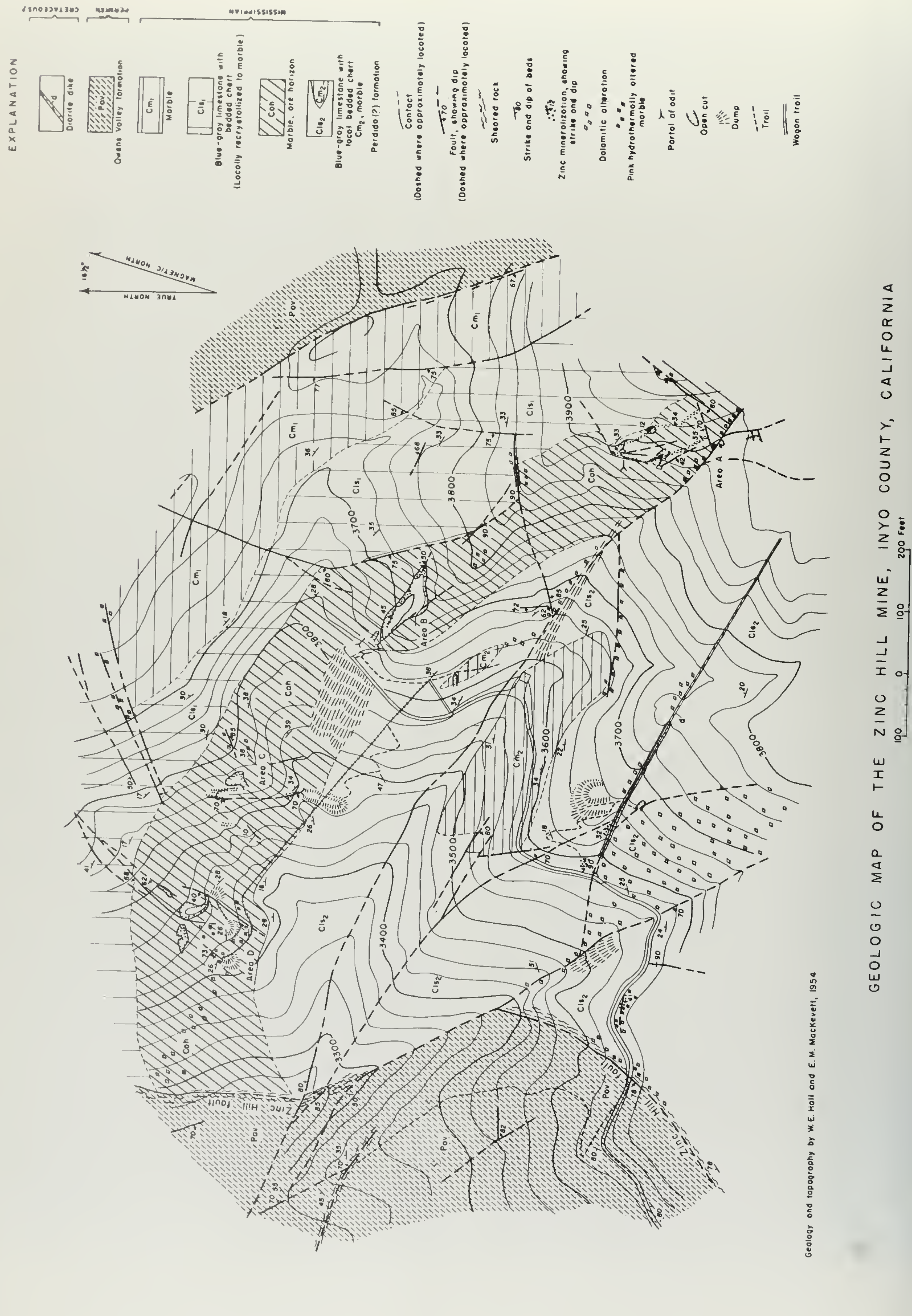


FIGURE 14. Geologic map of the Zinc Hill mine

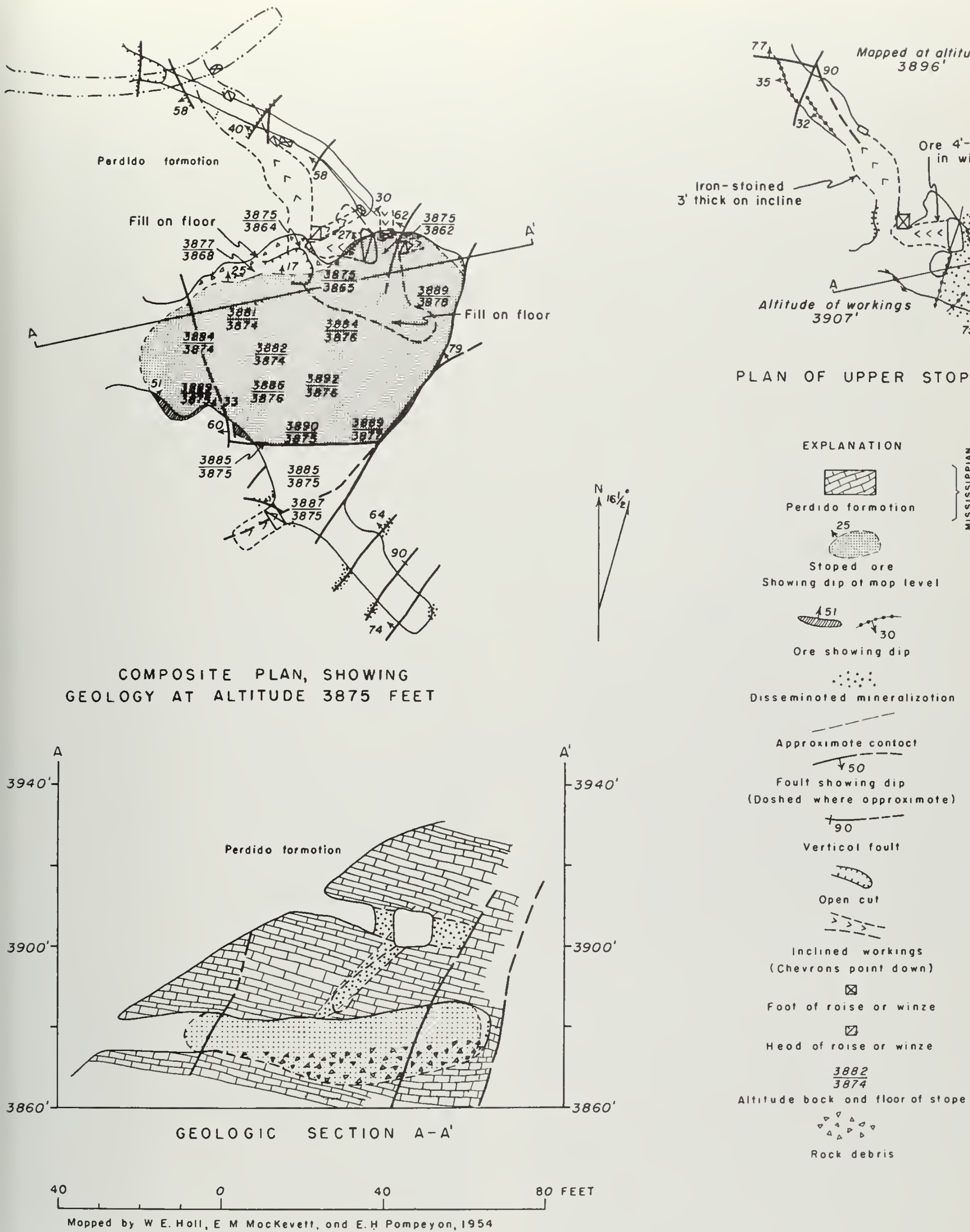


FIGURE 15. Geologic maps and section of the upper workings in Area A, Zinc Hill mine.

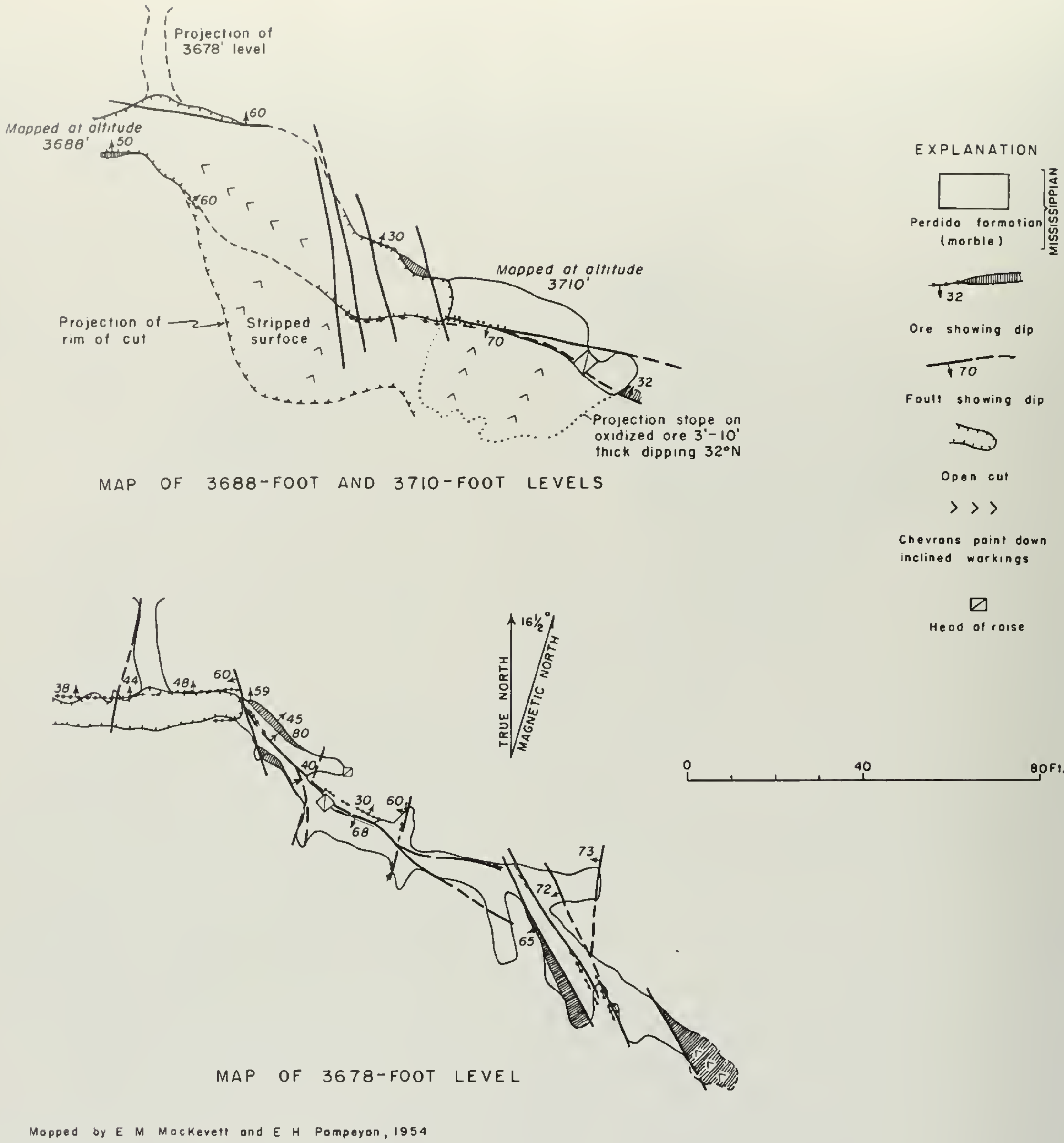


FIGURE 16. Map of workings in Area B, Zinc Hill mine.

The faults must have had several periods of movement. Many of the northwest- and northeast-trending faults are mineralized or dolomitized, yet the northwest-trending faults apparently displace the Zinc Hill fault, which has had late Tertiary or Quaternary displacement.

The ore occurs as replacement bodies parallel to bedding and to a lesser extent along faults where they cut a favorable stratigraphic horizon (fig. 14). The favorable ore horizon crops out for 1,500 feet in a northwesterly direction, and it is cut off by faults at both ends. Mineable ore bodies are in four localities within this favorable horizon. The ore in areas A and D is mainly parallel to bedding, while the ore bodies in areas B and C are mainly along steeply dipping faults (fig. 14).

Ore in the upper workings in area A is mainly in bedded replacements in what is called the Colorado bed by the Combined Metals Reduction Company (written communication). The Colorado bed is at the top of the favorable ore horizon. As the ore within the Color bed was mined out when the mine was mapped, det within the bed were not evident. The Colorado be described by L. G. Thomas (written communicati geologist for Combined Metals Reduction Company follows:

"The deposit is a replacement type composed of at least 3 possibly 4 distinct beds intercalated between ribs or part within the Colorado bed and adjacent to a feeder fissure, called Herbert fissure, which strikes N. 35° E. and dips 60° to 75 the northwest. The sequence within the Colorado bed is in ger as follows:"

Upper bed No. 4	Ore, 2+ feet
Limestone parting	Waste, 6 feet
Bed No. 3	Ore, 4 to 6 feet
Limestone parting	Waste or low grade, 3-4 fee
Main bed No. 2	Ore, 5-8 feet
Limestone parting	Waste or low grade
Bottom bed No. 1	Ore, 3-4 feet

re in the upper workings in area A was mined from stopes (fig. 15). The lower stope is approximately feet long, 60 feet wide, and 10 to 16 feet high. Ore n beds Nos. 1 and 2 was mined from this stope. Ap- ximately a third of the ore removed from this stope primary ore and the rest oxidized ore. The upper e is approximately 25 feet long, 25 feet wide, and 4 to 7 feet high. It apparently contained only oxidized The Royal Wright winze was sunk 22 feet from the er stope on oxidized ore 4 to 7 feet thick with some ct sphalerite and galena along fractures striking N. E. and dipping 37° NW. These fractures are con- ous between the upper and lower stopes. Two bedded bodies each about 30 feet long, 25 feet wide, and uch as 10 feet thick were mined in area D. This ore cally cut by faults, and oxidized ore extends a short ance along the faults.

mall oxide ore bodies are localized along faults in s B and C. In area B, ore is stoped discontinuously a distance of 200 feet along a fault zone striking N. W. and dipping 30° to 50° NE. (fig. 16). The ore to 10 feet thick and is stoped about 50 feet down the Oxide ore is still exposed on the lower level (fig. 16). at the east end of the open stope in area B termi- s against a mineralized fault that strikes N. 30° W. dips 65° SE. Ore 1 to 12 feet thick was mined 50 along strike and 40 feet down dip; ore 2 to 4 feet k is exposed at the bottom of the stope.

mall, discontinuous ore bodies both parallel to bed- and along faults were mined in area C. The largest body is a bedded deposit that strikes east and dips N. It is stoped 40 feet along strike and 30 feet down dip; it has a thickness of 3 to 6 feet. Other small es of ore occur along faults.

he primary ore contains sphalerite, galena, pyrite, chalcopyrite in order of decreasing abundance in angue of calcite, jasper, gypsum, and quartz. Sphal- e is the predominant primary ore mineral. It is wn to yellowish-brown and has a resinous luster. The n size is ½ to 4 mm in diameter. Galena is only locally ndant. It commonly has a bluish color due to a thin ered film containing copper. Pyrite and chalcopyrite present in minor quantities.

lost of the ore that remains in the mine is oxidized ore. It is a crumbly, porous, brownish-colored mass consists mainly of hemimorphite, hydrozincite, and onite, and lesser amounts of cerussite, anglesite, thsonite, and some blue and green secondary copper erals.

lemimorphite is the principal supergene mineral, and ust have made up nearly 100 percent of the oxide that was mined. The hemimorphite forms crumbly sses of colorless, white, or cream-colored crystals that admixed with limonite. Locally the crystals are ned pink, red, or deep green. Hydrozincite is con- trated near the borders of oxidized zinc ore bodies, ticularly in area C. It forms a white, powdery coat- on chalcedony and on vugs and is admixed and ded with clay minerals. Smithsonite is rare. It is in veinlets away from the zinc ore bodies and has been nsported farther than the other supergene zinc erals.

'erussite and anglesite are present in small quantities where observed are always near relict galena. Angle- site admixed with cerussite is restricted to a dark-gray rim several millimeters thick surrounding galena, while cerussite was not observed more than a few centimeters from galena. Where the ore is completely oxidized, mainly zinc minerals are present.

Supergene copper minerals of various shades of blue and green are on the dump and in the lower adit in area C. Azurite and malachite are the most abundant.

Locally the secondary ore is slightly radioactive. Local radioactivity in a vein of hydrozincite in the lower adit in area C is 0.05 to 0.2 MR/hr, and averages about 0.08 MR/hr compared to a background of 0.02 MR/hr. The surface exposure of the vein has about the same amount of radioactivity. The upper workings in area C also are radioactive and give readings as high as five times the background count. The source of the radioactivity is not known.

Mines and Prospects in the Santa Rosa Hills and Inyo Mountains

Lee Mine (Emigrant Mine)

The Lee mine includes 6 claims in sec. 23 (projected), T. 17 S., R. 40 E., 11.8 miles N. 5° W. of Darwin at an altitude of 5,280 feet. Mrs. Agnes Reid of Panamint Springs owns the mine, and it is leased to Albert F. Glenn. A view of the mine area is shown in photo 7. The

Photo 7. View looking south at the Lee mine. The Tin Mountain limestone (Ctm), Perdido formation (Cp), Lee Flat limestone (Clf), and quartz monzonite (Kqm) are in the distance.

mine, formerly known as the Emigrant mine, was one of the early silver producers. Its history has been marked by many small-scale operations by lessees and intermittent periods of inactivity. The main production probably was during the 1870's and early 1880's, but no production records are available for this period. An early description of the mine by Burchard (1884, p. 163) is given below:

"Emigrant mine with a shaft 100 feet in depth and lateral drifts which show a vein 4 feet wide, with a rich streak of gold and silver on both walls. On the hanging wall side the streak is 6 inches and on the footwall side 12 inches. Assay $200 per ton. The ore is sacked and shipped to San Francisco."

This description probably refers to the inaccessible shaft and workings on the major steep northeasterly dipping vein west of the present main shaft. Some of

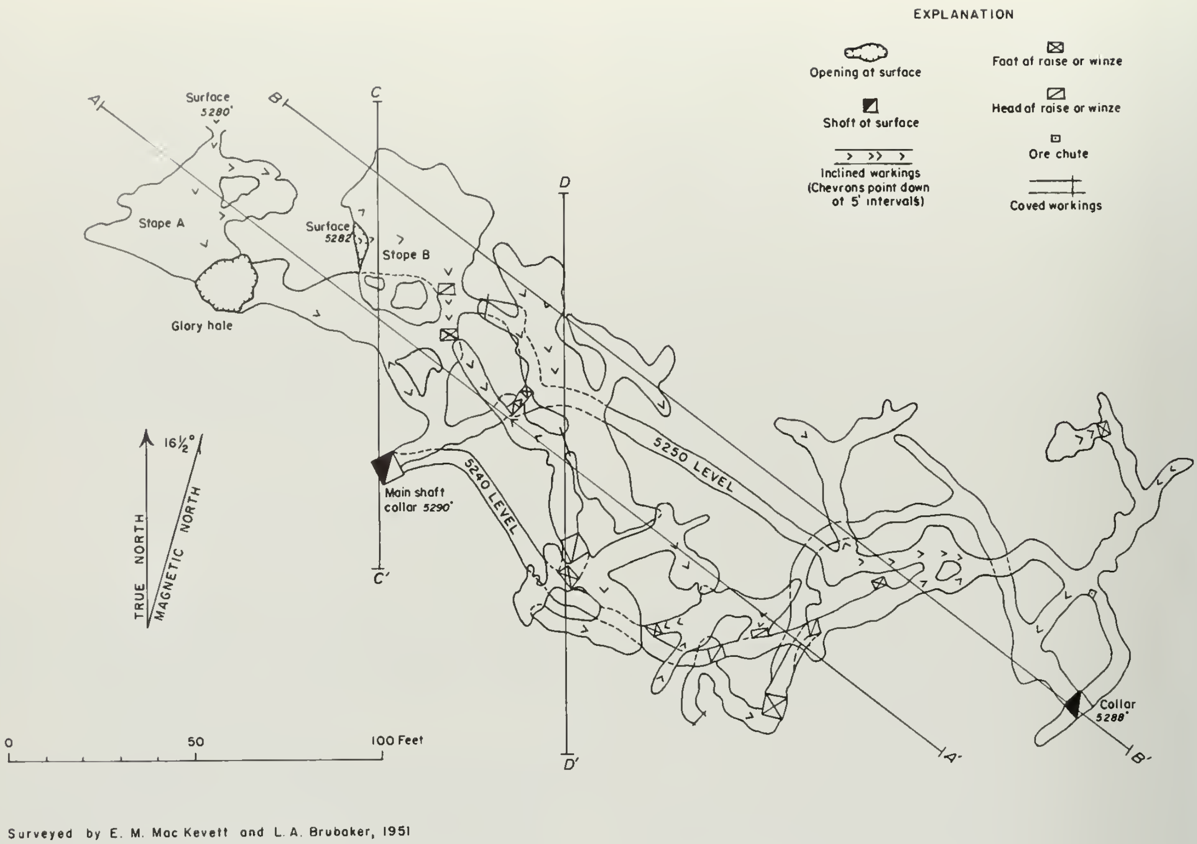


FIGURE 17. Composite map of the underground workings of the Lee mine.

the early Lee mine ore probably was milled in Mill Canyon at the site marked by the ruins of an old mill about 7 miles northeast of the Lee mine. Water was obtained from Lee pump about 8 miles northeast of the mine. DeGroot (1890, p. 213) mentions that the Lee district was waning by 1888.

The available production data probably account for only a minor part of the total output. During 1937, 250 tons of ore was shipped that averaged $49.00 per ton in silver (Tucker and Sampson, 1938, p. 443). Louis Warnken, Jr., shipped 226 tons of dump material in 1938 that contained 750 ounces of silver and 2 ounces of gold (production records of the U. S. Bureau of Mines). Recent production data are summarized below.

*Table 11. Recent ore production from the Lee mine.**

Year	Tons	Copper (percent)	Lead (percent)	Zinc (percent)	Silver (oz/ton)	Gold (oz/ton)
1951	41	0.4	2.4	16.3	61.3	0.025
1951	35	0.25	1.5	17.6	48.0	0.025
1952	44	0.45	1.5	22.75	89.76	0.035
1953	35	0.425	9.85	21.05	93.95	0.037
1953	42	0.24	7.9	17.75	59.6	0.025
1954	49	0.2	4.5	24.0	53.9	--

* Published with the permission of the mine owner.

Accessible workings in the main mine consist of more than 1,000 feet of levels and inclines and several thousand square feet of stopes (fig. 17). In addition, numerous inaccessible shallow workings adjoin the main workings on the northwest. The West Workings consist two short adits and an inaccessible shaft.

The Lee mine area is underlain predominantly by Tin Mountain limestone of Mississippian age (pl. The Lost Burro formation of Devonian age is exposed the northern part of the mine area and conforma underlies the Tin Mountain limestone. The Perdido f mation conformably overlies Tin Mountain limestone the southern part of the mine area and is overlain b thin flow of olivine basalt.

The Lost Burro formation exposed in the mine white, medium- to coarse-grained marble with thin ba of dark-gray marble. Some of the marble exposed in deepest mine workings may be part of the Lost Bu formation, although it is more likely bleached Tin Mo tain limestone. The Tin Mountain limestone is a mediu gray, fine-grained limestone in beds half a foot to 2 f thick. Dark-gray chert nodules and lenses are moderat abundant throughout the formation. The limestone c tains sparsely distributed tremolite crystals. All known ore deposits at the mine are within the lower p of the Tin Mountain limestone. The Perdido formati consists of medium-gray limestone interlayered w beds of dark-gray chert.

The Paleozoic rocks lie in a concordant sequence t strikes generally between N. 70° W. and west and d predominantly 20° to 40° SW. Most faults in the a strike parallel with bedding; the most conspicuous dips steeply northeast. Examples are the West fault a the large faults along the 5,240 and 5,250 levels (fig. 1 Where evidence is obtainable, these faults can be sho

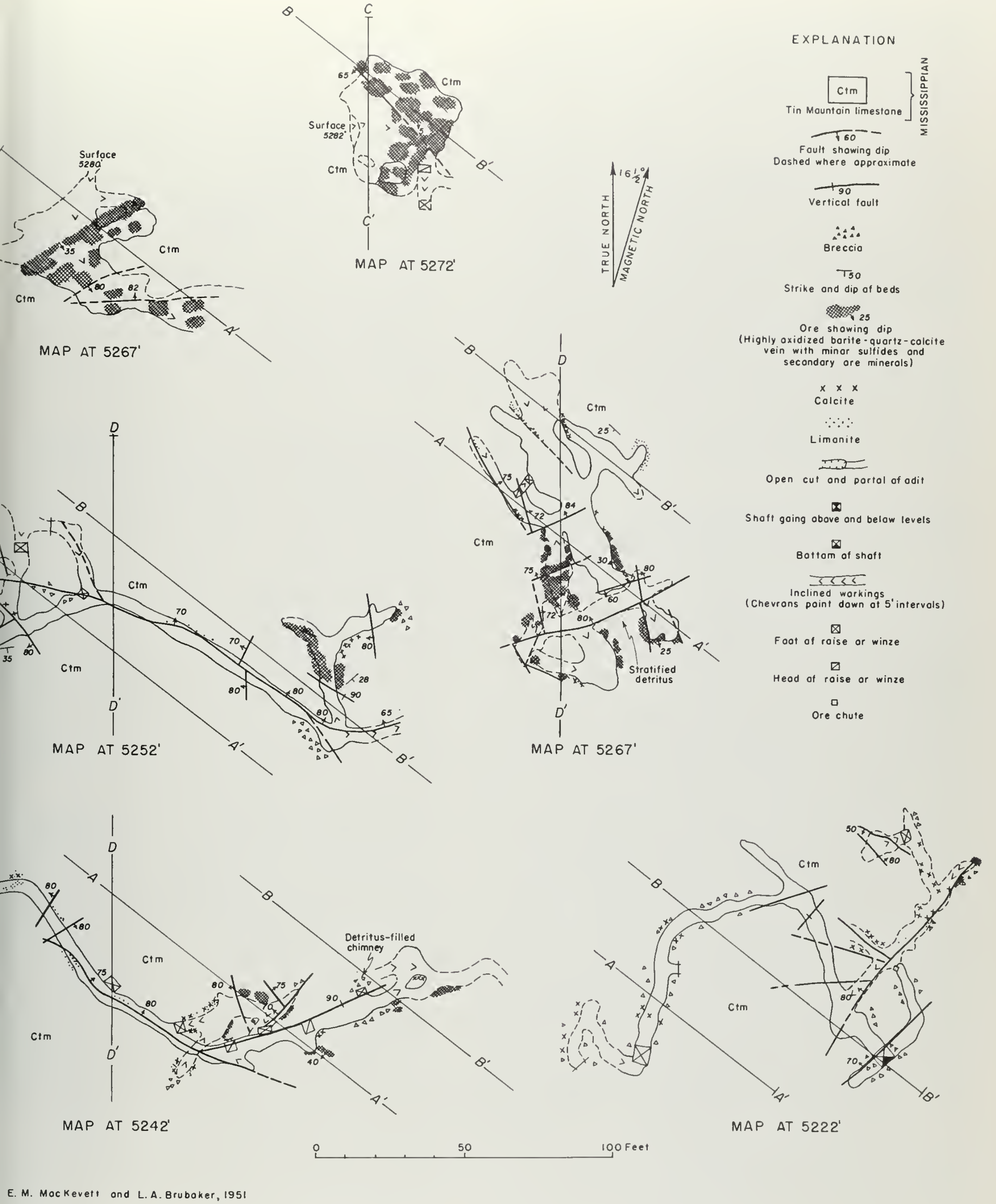


FIGURE 18. Geologic maps of the underground workings of the Lee mine.

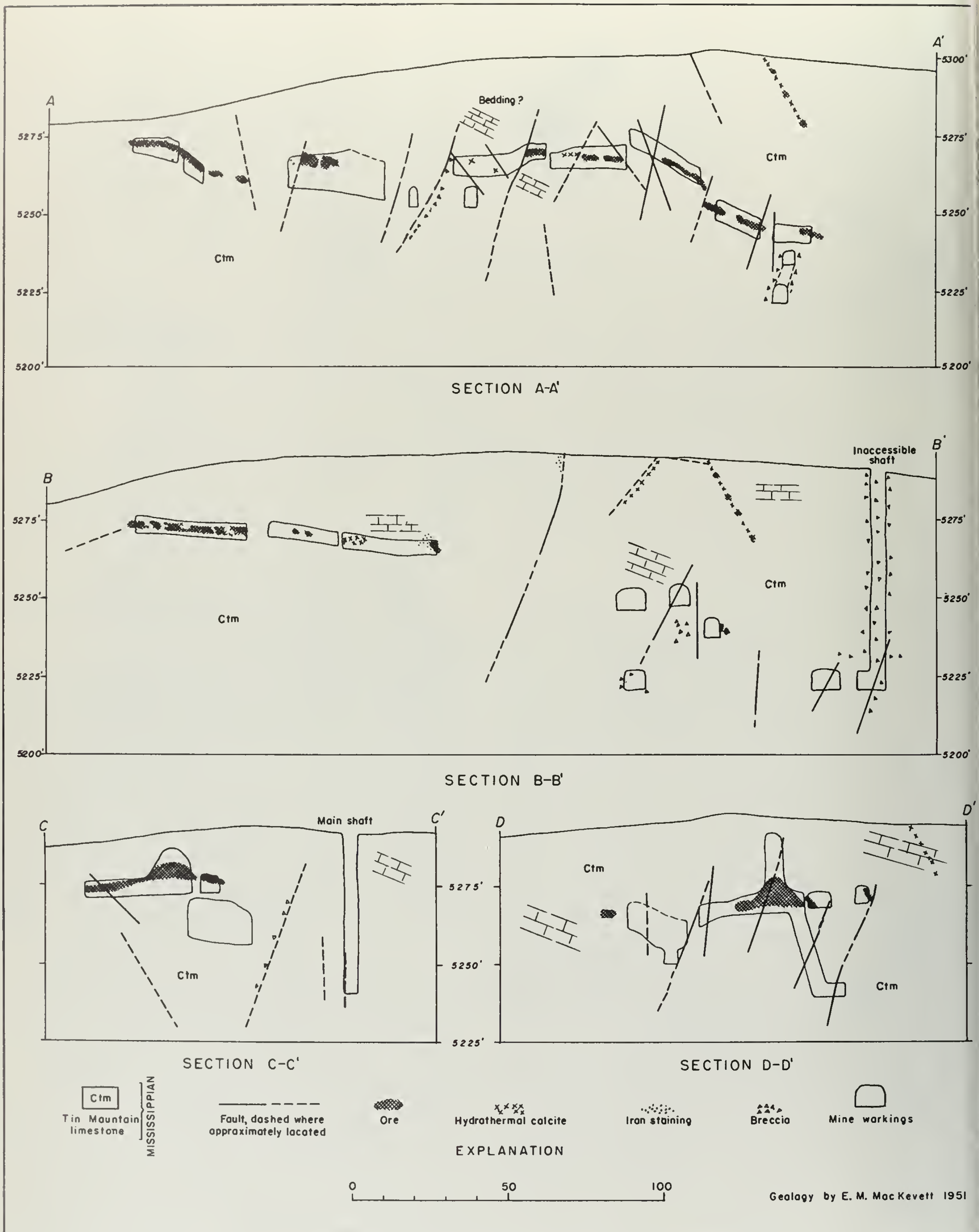


FIGURE 19. Geologic sections of the Lee mine.

e normal faults. The cumulative dip slip of the West t and two similar faults south of it is about 50 feet. ther less prominent fault set strikes parallel with ling and dips steeply southwest. Minor bedding-e faults are present locally.

ne rocks are brecciated and shattered in the vicinity ne main workings. Some of the brecciated rocks are nneylike and have a long vertical dimension; for nple, the breccia at the inaccessible shaft 100 feet S. E. of the main shaft is at least 70 feet long in verti-limension. Well-stratified subrounded material rang-in size from fine sand to pebbles occurs at two places ne mine in vertical pipelike bodies about 7 feet in neter circumscribed by near-vertical slickensides. e ore fragments are in the breccia. Both the chimney-breccias and the detritus-filled chimneylike bodies believed to be formed by the solution of limestone ng a period of abundant rainfall and the subsequent pse of the overlying rock. The well-stratified ma-l was deposited in the solution cavities prior to the pse.

re occurs as discontinuous, flat-lying bodies that are art controlled by bedding or bedding-plane frac-s. The size and shape can best be inferred from the ensions of the old stopes (figs. 18, 19). The largest es are about 1,400 square feet in area, about 16 feet naximum height, and 6 feet in average height. Ore es exploited in recent years were considerably ler, and, in general, yielded between 50 and 100 tons re each.

ost of the ore is oxidized and only relicts of the pri-y minerals remain. Hemimorphite is the most abun-ore mineral. It is in radial and divergent aggregates ght-gray to colorless crystals associated with cerar-te, which economically is probably the most impor-mineral. The cerargyrite is in euhedral olive-green tals that are cubes 0.2 mm on a side modified by octa-al faces. In addition aurichalcite, azurite, bindheim-cerussite, chrysocolla, and native copper have been tified.

alena is the most abundant primary ore mineral. It resent as relicts 1 inch to 4 inches in diameter sur-nded by oxidized ore minerals. Cerussite and angle-are found only where relict galena is evident. Minor unts of sphalerite, pyrite, and tetrahedrite are in primary ore. The sphalerite is in irregularly shaped ments as great as an inch in maximum dimension is a resinous light brown. Barite, quartz, calcite, and cedony are the principal gangue minerals and gyp-and clay minerals are in small quantities.

he most important ore bodies are near fault zones re the rocks are in part brecciated and shattered. nough most ore bodies are shallow dipping and gen-ly conform to bedding, locally they steepen and ap-ntly transect bedding. Some of this steepening may drag effect of post-ore faulting. The favorable ore occupied by the discontinuous ore bodies plunges ly to the southeast (see fig. 19, section A-A′).

here steep northeast-dipping faults, such as the West t, are mineralized, they contain abundant quartz, ite, yellow and brown ocherous iron oxides, and cedony, but they contain little ore minerals. Move-t on the steep faults was probably instrumental in ning open fractures parallel to bedding that served as locii for ore bodies, but the steep fractures served only as channelways for the ore solutions. Slickensided selvages and local shattering indicate some post-ore movement. The northeast-dipping fractures in places off-set the shallow-dipping ore bodies of the main workings.

Santa Rosa Mine

The Santa Rosa mine is in secs. 26 and 35 (projected), T. 17 S., R. 39 E., in the southern part of the Inyo Mountains at an altitude of 6,500 to 7,100 feet. The mine is described in detail by Mackevett (1953), and his re-port is summarized here.

Workings consist of the 352-foot Hesson inclined shaft, several shallower shafts, about 1,500 feet of drifts and crosscuts, and extensive stopes. In addition, an 1,800-foot westerly trending crosscut adit was driven in 1953 to explore the known veins at greater depth.

The mine is the eighth largest lead producer in the State. From the time of its discovery in 1910 until 1950 the mine produced 36,854 short tons of ore containing 11,990,792 pounds of lead, 487,347 pounds of copper, 4,105 pounds of zinc, 426,543 fine ounces of silver, and 478.7 fine ounces of gold (Mackevett, 1953, p. 4). Lessees have mined some ore from the new deeper workings since 1953.

The mine is within an inlier of the lower limestone member of the Owens Valley formation of Permian age that has been metamorphosed to calc-hornfels. The inlier is approximately 2,000 feet long and 600 feet wide. It is encircled by Tertiary and Quaternary volcanic rocks consisting of olivine basalt, tuff, tuff-breccia, agglom-erate, and andesite. The calc-hornfels is a dense, fine-grained rock that is greenish-gray on fresh surfaces and weathers brown. It consists mainly of calcite, quartz, and diopside and minor amounts of zoisite, garnet, epidote, limonite, and opaque minerals. Minor beds of unsilicated bluish-gray limestone that are locally fossiliferous are interbedded with the calc-hornfels.

Andesite porphyry dikes, which were called syeno-diorite porphyry by Mackevett (1953), are 2 to 6 feet thick, strike N. 70° W., and dip nearly vertical. These dikes cut the Owens Valley formation of the inlier but do not cut the adjacent volcanic rocks. Northeast-trend-ing, steeply dipping basalt dikes 2 to 16 feet thick cut both limestone and volcanic rocks.

The inlier of calc-hornfels is structurally a horst. The Santa Rosa fault bounds the inlier on the east, and another steep fault forms part of the western boundary of the inlier. The Santa Rosa fault is a north-trending normal fault that dips about 80° E. The east block has been downfaulted probably at least 250 feet. Rocks of the inlier strike N. 10°-20° W. and dip 30°-70° NE. Faults of prevolcanic age within the inlier contain the ore-bearing veins. The most important faults strike par-allel with bedding and dip 30° to 60° SW. Some of the ore-bearing faults strike parallel with bedding and dip 55° to 80° NE. or strike about east and dip nearly vertically.

Ore is in veins within prevolcanic faults. At least 12 veins are exposed. They range from less than 100 feet to 700 feet in length and average between 3 and 4 feet in thickness. West-dipping veins are the most abundant and productive. Fissure filling was the dominant process involved in the emplacement of the veins.

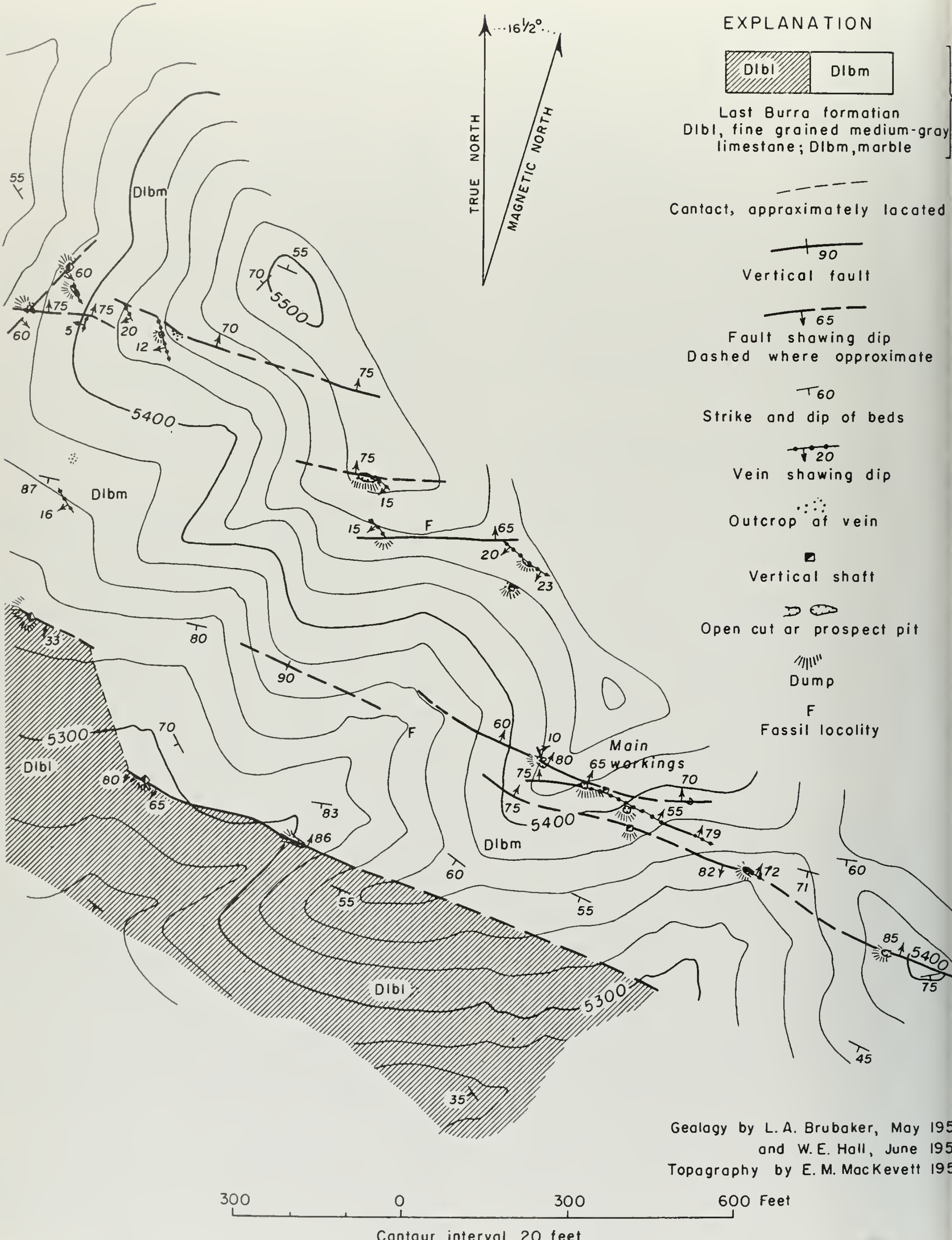


FIGURE 20. Geologic map of the Silver Reid prospect.

veins are highly oxidized and consist chiefly of ite and hemimorphite in an iron-stained silica- and -rich gangue. The primary ore is composed mainly rite, sphalerite, and galena with subordinate ar-yrite and chalcopyrite. The grade of ore within a s erratic, and the richest ore occurs in shoots in icker parts of veins. Outlines of workings indicate nost of the production from the Hesson vein, eco-ally the most important vein, was from a shoot aked gently to the north.

adit was driven under the mine workings by The nda Company to explore the veins at depth. The vas driven westerly 1,800 feet at an altitude of 6,580 feet from the sharp bend in the road at the f the tramway from Upper Sanger workings. (See evett, 1953, pl. 2.) The adit is completely in calc-els. The ore showings in the adit are sparse. Most veins have pinched out above the level of the out some zinc-rich primary ore was discovered and eing mined in 1955.

ver Reid Prospect

Silver Reid prospect is 12.5 miles north of Darwin southeastern part of the Santa Rosa Hills in sec. rojected), T. 17 S., R. 40 E. The prospect is ac-e by a dirt road that leads from the Saline Valley mile east to the Lee mine; the property adjoins ee mine on the north. The surface geology was mapped by L. A. Brubaker and E. M. Mackevett in May 1951 and additions were made by W. E. Hall in July 1953.

The Silver Reid prospect was staked in 1924 by W. A. Reid, and it is now owned by his widow, Mrs. Agnes Reid of Panamint Springs, Calif. The property has been prospected intermittently since 1924, and by 1951, development work consisted of about 25 shallow pits and shafts and several near-surface stopes. No production has been recorded from the property, but a small production may have been lumped with that of the Lee mine.

The Lost Burro formation of Devonian age crops out in the prospect area (fig. 20). It is conformably overlain by Tin Mountain limestone of Mississippian age south of the prospect at the Lee mine, and it is unconformably overlain by flat-lying basalt of Tertiary or Quaternary age and by alluvium to the west and north of the prospect. A section 1,500 feet thick of the Lost Burro formation is exposed in the area. It consists of white, medium- to coarse-grained marble that is characteristically banded parallel to bedding and contains streaks and thin beds of dark-gray marble less than an inch thick. Quartzite lenses are locally in the white marble. Fine-grained, medium-gray limestone beds as much as 50 feet thick are interbedded with the white marble in the northeast part of the prospect area near the base of the exposed section of Lost Burro. Thin

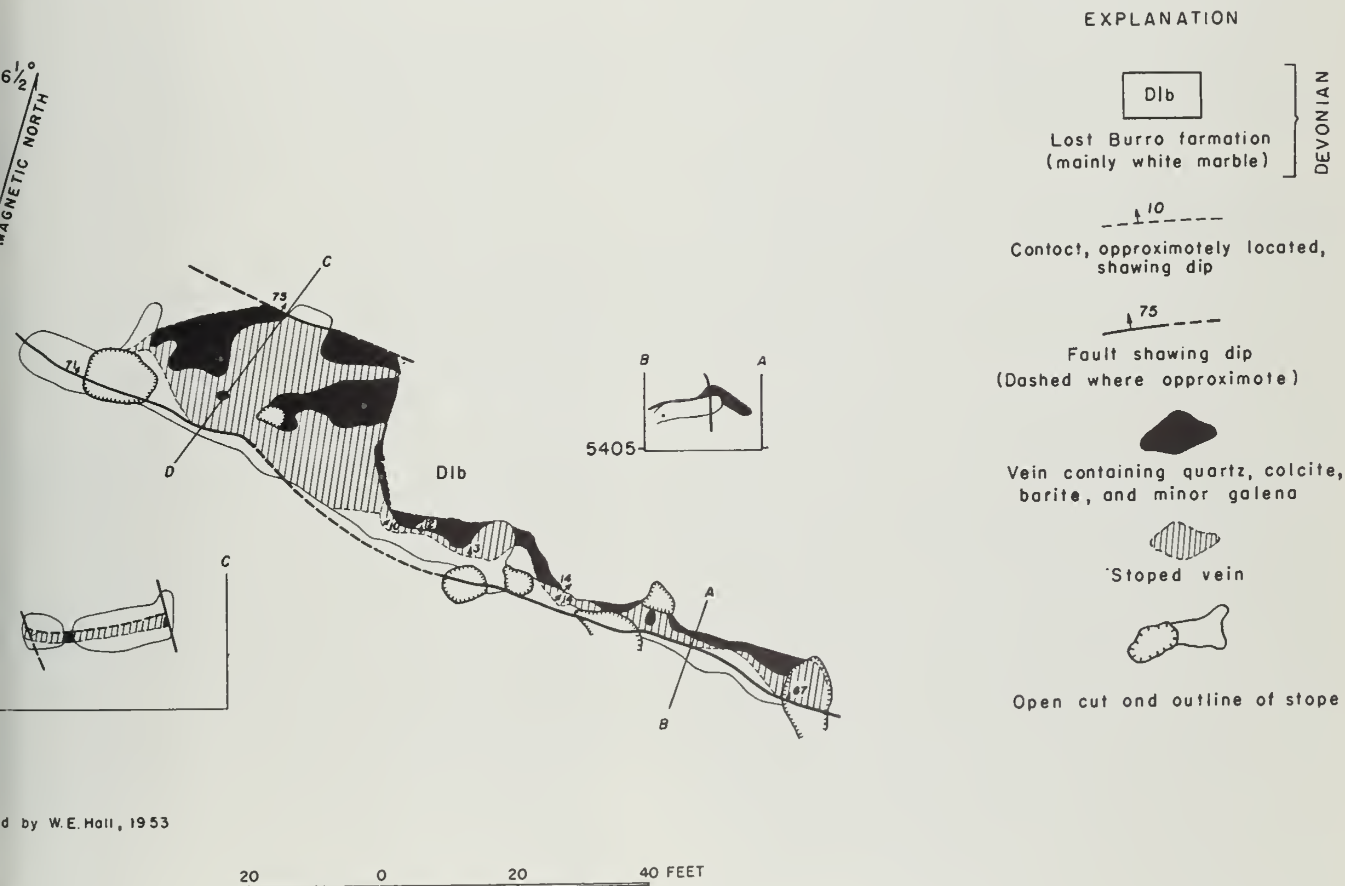


Figure 21. Geologic map of the main stope of the Silver Reid prospect.

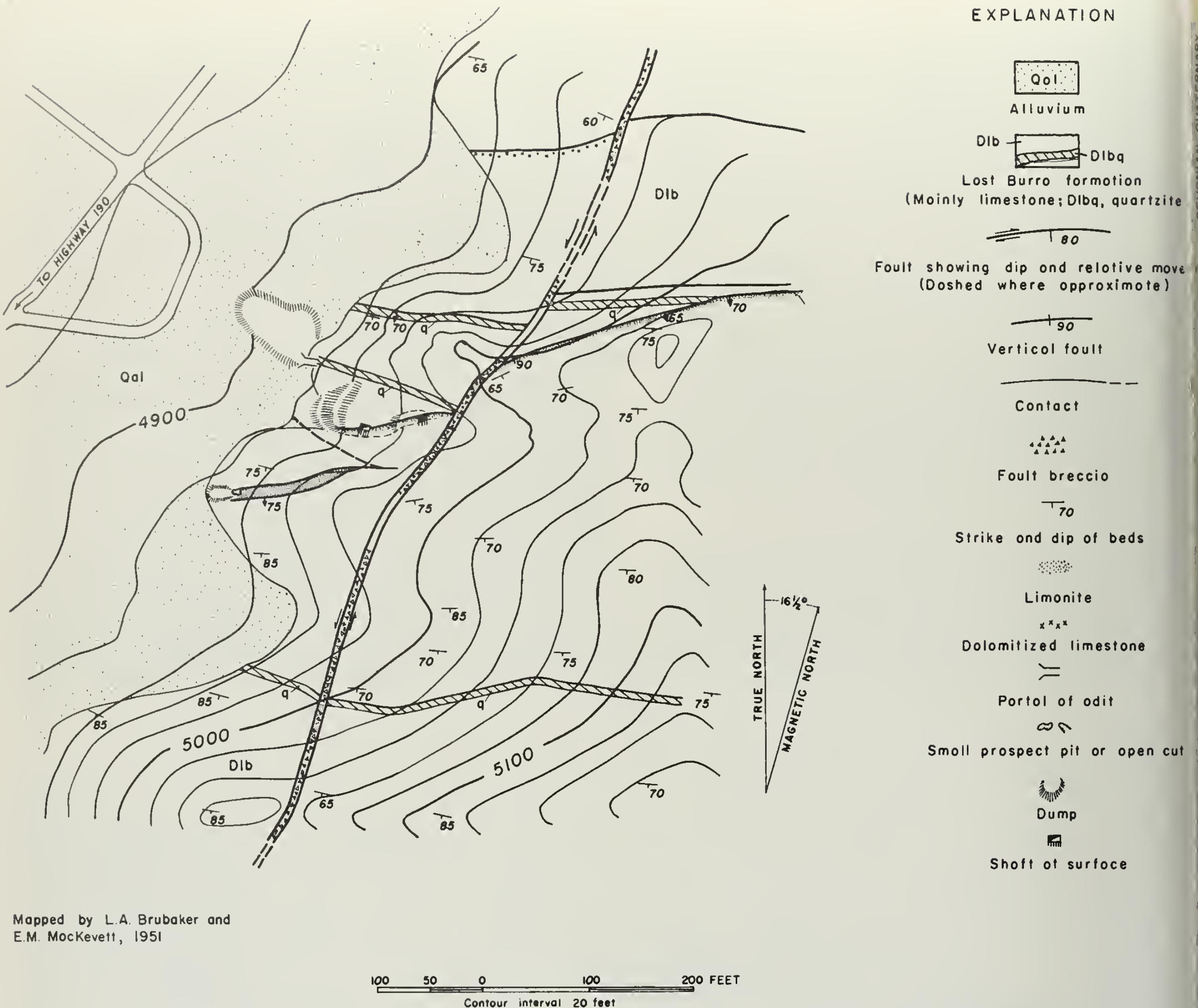


FIGURE 22. Geologic map of the Cactus Owen prospect area.

chert interbeds are abundant in the medium-gray limestone near the base of the exposed section.

Bedding in the Lost Burro formation strikes N. 45° W. to west and dips southwest to south from 35° to 87° except for local steep northeast dips near the crest of the hill. Two sets of faults are evident in the mine area. One set strikes about N. 70° W., approximately parallel to the strike of bedding, and dips steeply either to the north or south. The other set strikes N. 20°-70° W. and dips gently southwest. The flat faults have no appreciable displacement and are probably fractures formed by differential movement along the steep major faults. The major faults strike parallel to bedding, but in general dip more steeply than bedding. They are believed to have mainly a strike-slip displacement.

Ore is localized in small bodies in flat-lying faults near major steeply dipping faults striking N. 60°-80° W. Most of the steep faults are only slightly mineralized. The largest known ore body has been stoped over an area 40 feet long and 20 feet wide, and it has an ave thickness of 2 feet (fig. 21). At least five other flat v are exposed on the surface or in shallow prospect (fig. 20) to the northwest of the main stope, but n are extensively developed.

At a few places the steep N. 60°-80° W. faults loca the vein material. At the west side of the Silver prospect an inclined shaft has been driven to a de of 56 feet on a N. 70° W.-striking fault. At the sur the fault shows little mineralization, but a 30-foot d at the bottom of the inclined shaft exposes a vein 3 feet thick, and a winze has been driven on the to a depth of 10 feet below the level. The steeply-dipp vein is similar in mineralogy to the flat-lying veins.

The veins consist of minor galena and pyrite i gangue of quartz, calcite, and barite. Secondary cop minerals and a yellow antimony mineral, probably b heimite, are present locally. No silver minerals were s ttle data are available about the grade of the ore. rt Glenn (oral communication, 1954), lessee of the ining Lee mine, sampled the dump near the Main e and reports the sample assayed 18 ounces of silver ton.

s and Prospects in the Talc City Hills

actus Owen (Midway) Prospect

e Cactus Owen prospect is in sec. 25 (projected), 3 S., R. 39 E., on an isolated hill $1\frac{1}{2}$ miles N. 70° W. e Talc City mine, at an altitude of 5,000 feet. The pect has no recorded production. Workings consist clined shafts 40 and 200 feet deep, a short adit, and t 300 feet of levels.

mestone and quartzite of the Lost Burro formation evonian age crop out in the prospect area (fig. 22). limestone is a light-gray, bleached rock in beds 1 to 4 feet thick. It is recrystallized and shows evi- e of intense deformation. Several quartzite beds 1 to 12 feet thick are interbedded with the limestone. quartzite is medium-gray on fresh surfaces and hers light brown.

e sedimentary rocks strike N. 80° W. to west and steeply south. They are cut by a steep fault that es N. 20°-30° E. The fault is marked by an iron- ed breccia zone about 10 feet thick. Other faults are llel or nearly parallel to bedding. They are iron ed and in some places have local pockets of quartz calcite. Workings have mainly developed the bed- plane faults.

e only ore minerals observed were found on the and consisted of a few scattered galena fragments iated with quartz and minor quantities of pyrite specular hematite. Calcite commonly coats and veins tz. Minor gossan is exposed in a few places but ap- s barren of ore minerals.

omestake Mine

e Homestake mine is 2,000 feet northwest of the City mine in sec. 30 (projected), T. 18 S., R. 40 E., altitude of 5,520 feet. The mine is owned by Edith hart and George Koest. Workings at the Homestake ber 1 claim consist of inclined shafts 50 feet and 150 deep and workings on the adjacent Homestake num- claim include a 45-foot adit trending S. 33° W. and -foot drift trending N. 45° W.

e country rock is thin-bedded bluish-gray limestone e Lost Burro formation that strikes N. 70° W. and 70° SW. The mine workings follow major shear . The major structure at the Homestake number 1 is a shear zone 2 to 10 feet thick that strikes N. W. and dips 70° SW. The upper workings are on tz-rich shear zones as much as 6 feet thick that e N. 45° W. and N. 33° E. and dip steeply south. sheared limestone is iron stained and is locally re- d by dolomite. In places the shear zones are re- d by pockets of quartz and minor calcite, cerussite, morphite, and oxidized copper minerals.

ilver Dollar (Domingo) Mine

e Silver Dollar mine is 2,600 feet east of the Talc mine in sec. 29 (projected), T. 18 S., R. 40 E., in astern part of the Talc City Hills at an altitude of feet. It is owned by Edith Lockhart and George Koest, mailing address Darwin, Calif. Early mining operations were for lead and silver, but in recent years talc deposits have been exploited on some of the claims. Production data from the files of the U. S. Bureau of Mines, San Francisco office, for the metalliferous deposits are given below. These data are given under the name Domingo, a former name of the mine. George Koest provided much of the following historical information.

*Table 12. Ore produced from the Silver Dollar (Domingo) mine.**

Year	Gold (oz)	Silver (oz)	Copper (lbs)	Lead (lbs)
1910	--	5,360	--	107,000
1911	1.79	12,247		326,578
1913	1.45	1,117		35,374
1915	--	970	229	830

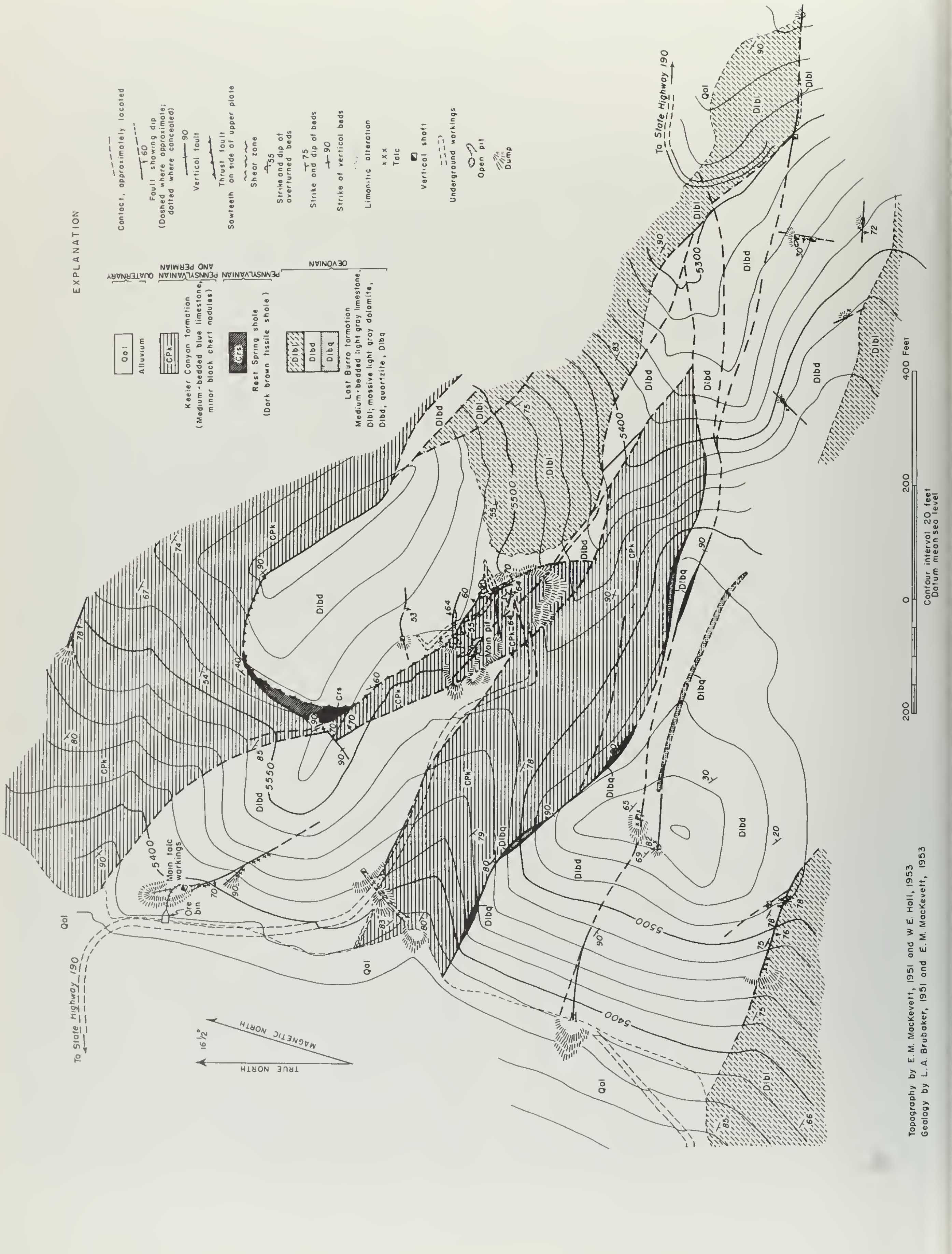
* Production figures furnished by the U. S. Bureau of Mines and published with the permission of the mine owners.

Ore was first discovered on the property in 1910 at the site of the main pit and all the recorded production was made during the ensuing five years. During late 1910 and early 1911 a shaft, sunk to a reported depth of 90 feet, explored a vertical vein on the south side of the main pit. During the next four years, lessees enlarged the main pit and drove short drifts along a vein dipping to the northeast, backfilling the original shaft. This northeast-dipping vein was followed for 100 feet down the dip before work was abandoned in 1915. During the late 1930's the present owners sunk a 130-foot shaft 100 feet east of the main pit. Crosscuts were driven from the bottom of the shaft to points under the main pit, but no ore was found. The main talc workings consist of a 75-foot inclined shaft with several hundred feet of drifts and crosscuts.

The Silver Dollar mine is in a complexly faulted area underlain by the Lost Burro formation of Devonian age and the Keeler Canyon formation of Pennsylvanian and Permian age (fig. 23). Minor Rest Spring shale of Pennsylvanian age crops out in fault zones. The Lost Burro formation consists mainly of massive light-gray dolomite but includes some medium-bedded, light-bluish gray limestone and minor quartzite. The Rest Spring shale is a dark-brown fissile shale that is localized along a thrust plane. Bluish-gray thin-bedded cherty limestone of the Keeler Canyon formation is the host rock for the lead-silver ore.

The Devonian rocks are thrust over the Rest Spring shale and the Keeler Canyon formation. The best exposure of the thrust fault is about 300 feet north of the main pit where the Lost Burro formation overlies the Rest Spring shale. Numerous steeply dipping faults that strike about N. 50° W., approximately parallel to bedding, displace the thrust fault. Some of the northwest-trending faults contain dragged and shattered quartzite. Rocks in the thrust plate are strongly folded. The contact of limestone and dolomite 175 feet southeast of the main pit is parallel to bedding, and the structure is a faulted inverted syncline.

Ore from the main pit probably accounts for almost the entire mine production. The ore is in limestone of Pennsylvanian and Permian age in a fault zone that strikes N. 55° W. and dips steeply northeast. Judging


EXPLANATION
Qal
Alluvium
QUATERNARY
CPk
Keeler Canyon formation
(Medium-bedded blue limestone, minor black chert nodules)
PENNSYLVANIAN AND PERMIAN
Crs
Rest Spring shale
(Dark brown fissile shale)
PENNSYLVANIAN
Dlbl
Dlbd
Dlbq
Lost Burro formation
Medium-bedded light gray limestone, Dlbl; massive light gray dolomite, Dlbd; quartzite, Dlbq
DEVONIAN
Contact, approximately located
Fault showing dip
(Dashed where approximate; dotted where concealed)
Vertical fault
Thrust fault
Sawteeth on side of upper plate
Shear zone
Strike and dip of overturned beds
Strike and dip of beds
Strike of vertical beds
Limonitic alteration
Talc
Vertical shaft
Underground workings
Open pit
Dump
To State Highway 190
Main talc workings
Ore bin
Main pit
TRUE NORTH
MAGNETIC NORTH
16½°
Contour interval 20 feet
Datum mean sea level
400 Feet
Topography by E. M. MacKevett, 1951 and W. E. Hall, 1953
Geology by L. A. Brubaker, 1951 and E. M. MacKevett, 1953

n the size and shape of the main pit, the main ore y was about 35 feet long, 30 feet thick, and extended eet down dip. Little ore remains in any of the work-, but many faults in the mine area are strongly iron ned and contain quartz, calcite, and jasper. A com-ation of abundant local faulting and shattering and vorable host rock probably accounts for the localiza- of ore at the main pit. No data are available regard- the tenor of the ore.

he talc deposits are within dolomite of the Lost ro formation 650 feet northwest of the lead-silver The talc is in strongly sheared masses in a fault that strikes N. 20° W. and dips 70° SW. The de-its were not mapped. The talc is pale green and is ly laminated by shearing. Locally it contains some rite. Several of the N. 70° W.-trending faults in the thern part of the map area contain talc and they have explored by small pits (fig. 23).

Tungsten Deposits

by W. E. Hall, E. M. Mackevett, and D. M. Lemmon *

ribution

ungsten in the mineral scheelite has been recovered the Darwin quadrangle principally from mines in 18 and 19, T. 19 S., R. 41 E., in the east part of Darwin Hills 1 mile to 1½ miles east and northeast Darwin. Stolzite has been reported by Tucker and npson (1941, p. 567). However, D. M. Lemmon sub-ted similar material to Jewel Glass of the U. S. Geo-cal Survey as that from which stolzite was reported, the material was identified as scheelite mixed with er minerals but it contained no stolzite. Some schee- is present in the Thompson mine of the Darwin up, but it is intimately associated with galena and icult metallurgical problems have discouraged efforts ecover it except from local high-grade concentrations t were mined selectively and given special metallur-al treatment. A small amount of scheelite has been ned from deposits on the northeast slope of the Coso ge about 8 miles west and southwest of Darwin. All one of these deposits, the Lone Pinyon, which lies hin the quadrangle in sec. 26, T. 19 S., R. 39 E., are th of the Darwin quadrangle (pl. 1).

ome of the deposits in the Darwin district contain h scheelite and lead-silver minerals or scheelite and per minerals. The Custer, Defiance, Fairbanks, Jack- Lane, Promontory, Standard, Thompson, and Won- mines have both lead-silver and tungsten minerals. ese properties, which were developed mainly for their d-silver ore, are described under the heading, ''lead-c-silver deposits''.

tory and Production

Although scheelite was recognized in the Darwin ver-lead district during World War I, the deposits nained undeveloped until 1940. At this time Frank tkins purchased a group of patented claims on the t side of the Darwin Hills at a tax sale, relocated litional claims, and with C. W. Fletcher and others anized the Darwin Consolidated Tungsten Company develop the tungsten. In 1941 the E. L. Cord interests der the name Pacific Tungsten Company leased 23 mining claims from the Darwin Consolidated Tungsten Company, and during the ensuing twelve months they produced 30,940 tons of ore that averaged about 1 percent WO_3 (Wilson, 1943, p. 544). The ore was treated at a mill near Keeler owned by the West Coast Tungsten Corporation. This production was principally from the Durham, Fernando, St. Charles, and Hayward claims. Possibly 25,000 tons of tungsten ore has been mined in the district from 1944 to 1955.

Howard Miller and Louis Warnken leased the Durham-Fernando and St. Charles groups of claims from 1951 to 1953, and the Hayward and St. Charles group during 1951-1955. They erected a mill in Darwin Wash from which they recovered approximately 2,475 units of WO_3 from 1952 through 1954. The Ajax Tungsten Corporation, C. H. Hall, president, obtained a lease on the Durham and Fernando properties in 1954 and shipped some ore.

The scheelite in the Thompson mine of the Darwin group normally is not recovered except from local concentrations of high-grade ore that are mined selectively. Davis and Peterson (1948, p. 2) report that several hundred tons of high-grade scheelite ore containing 10 to 15 percent WO_3 have been mined, and scheelite was being stockpiled at the Darwin mine in March 1955. This high-grade ore was shipped to Tooele where it was fused with sodium carbonate and then leached with hot water for recovery of WO_3.

Some deposits about 1 mile east and southeast of Darwin were located originally in the 1890's for their copper showings, but they were operated briefly during World War II for tungsten. These include the Alameda and Toga claims. The Alameda claim is mentioned as a copper prospect by Aubury (1908, p. 313) under the name Richardson group, and part of the Toga claim is probably part of the Kingman claim described by Aubury (1902, p. 245).

Acknowledgments and Previous Work

The eastern part of the Darwin Hills, where the tungsten deposits are located, was mapped by Kelley (1938, pl. 7) as part of his study of the Darwin silver-lead district. He identified scheelite on the Bruce claim. A U. S. Geological Survey party under D. M. Lemmon studied the tungsten deposits from Nov. 3, 1941 to March 4, 1942. They mapped the Durham-Fernando-St. Charles area on a scale of 1 inch equals 200 feet and made larger scale maps of the underground workings. Their maps are published in this report, and with additional data supplied by Lemmon serve as the basis for the description of the tungsten deposits. The writers mapped the recent workings in the Fernando and St. Charles mines. The U. S. Geological Survey party under D. M. Lemmon also mapped the tungsten prospects in the Coso Range in Feb. 1942.

L. K. Wilson (1943, p. 543-560), geologist for the Pacific Tungsten Company, described the tungsten deposits in the Darwin district, their genesis, and the operations of the Pacific Tungsten Company from 1941 to 1943. The U. S. Bureau of Mines under D. W. Butner (1949, p. 2), project engineer, trenched and sampled nine properties in the Darwin district in 1941-42. Most of this work was done at the Silver Reef mine, owned by Mickey Summers' estate, at the south end of the

eologist, U. S. Geological Survey.

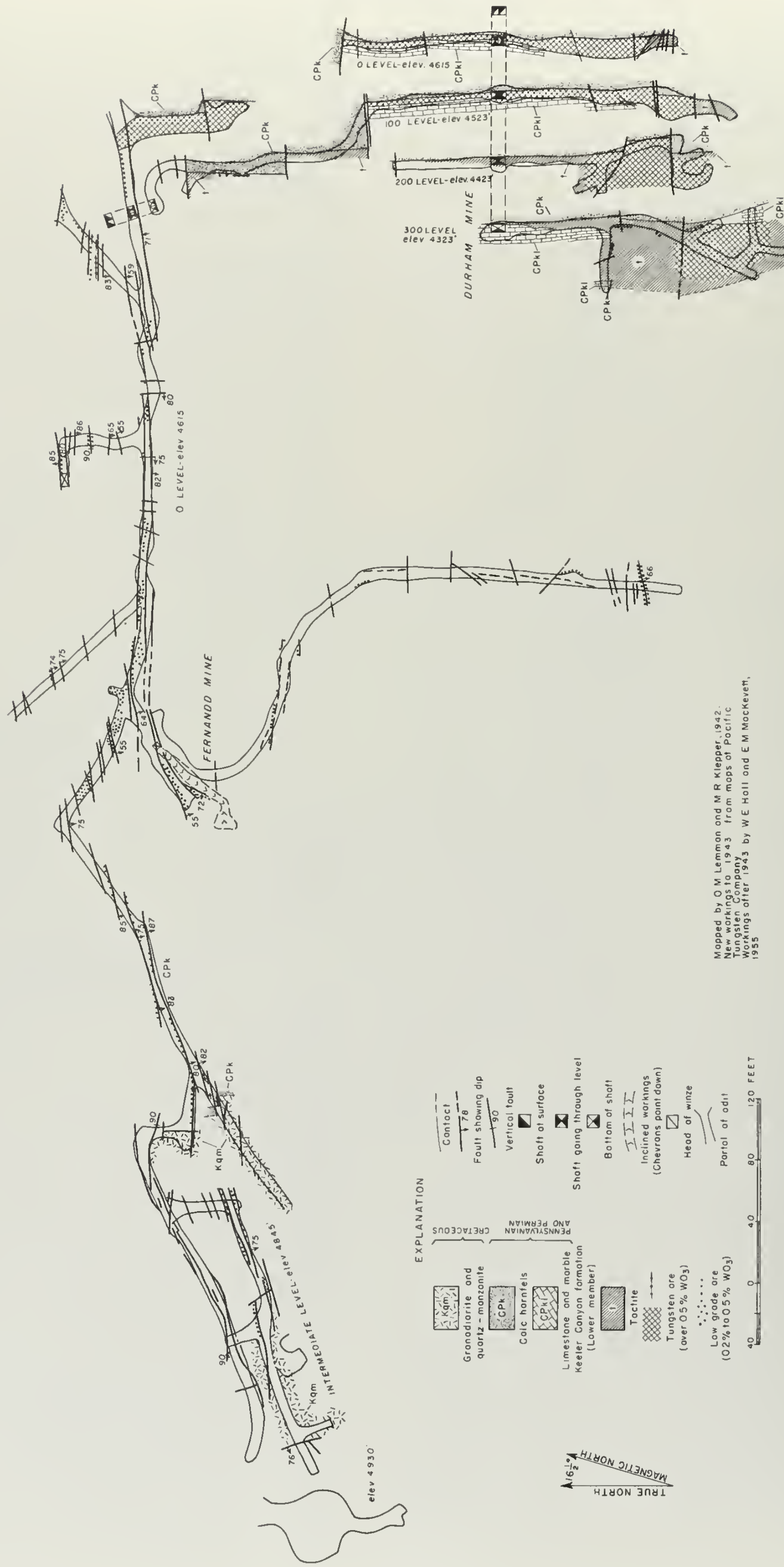


FIGURE 24. Geologic map of the underground workings of the Durham and Fernando mines.

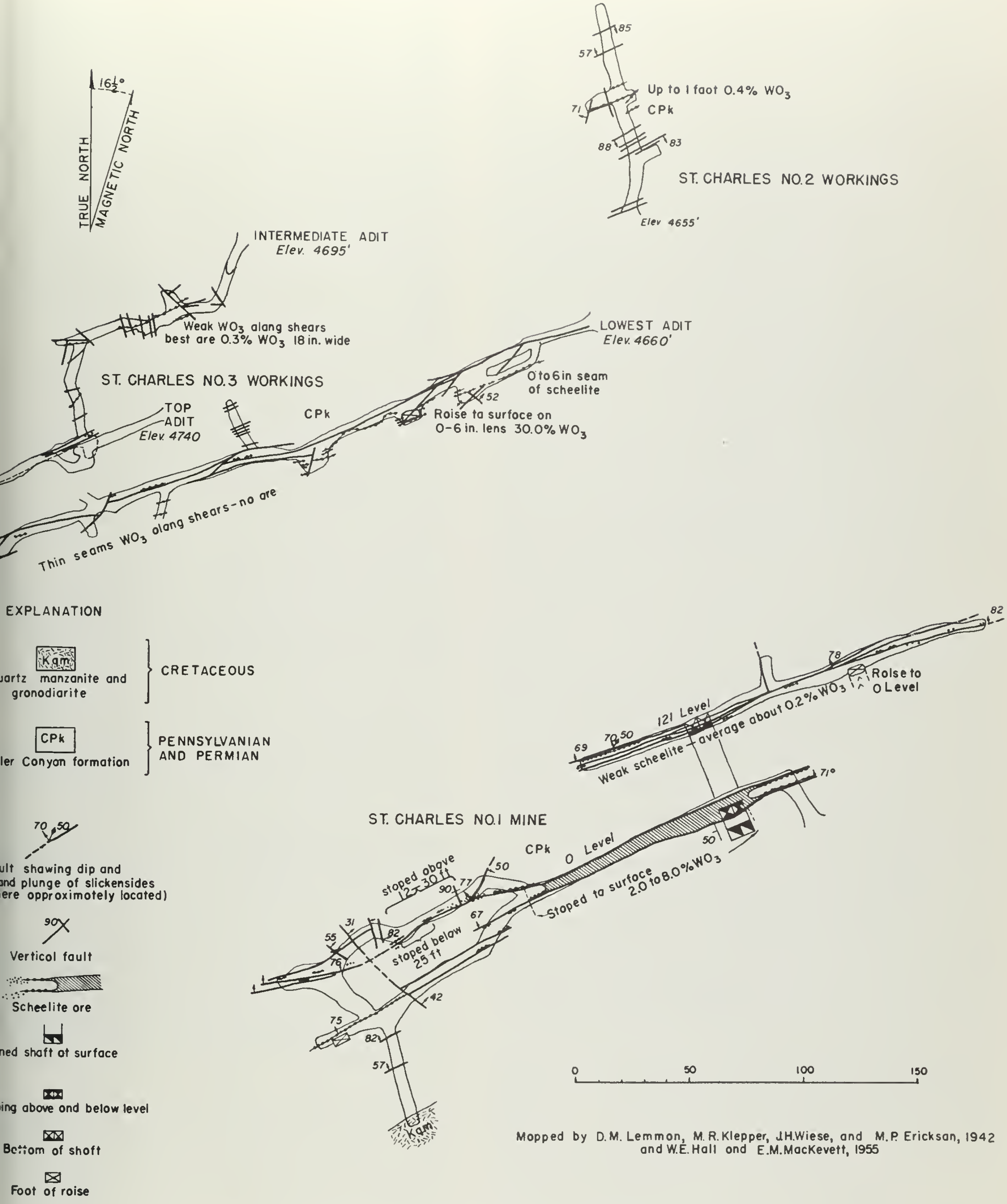


FIGURE 25. Geologic map of the underground workings of the St. Charles mine.

Darwin Hills south of the Darwin quadrangle, but some work was done on all the principal tungsten showings in the Darwin Hills.

Deposits in the Darwin District

Geologic Setting

Most of the tungsten deposits in the Darwin district are within metamorphosed rocks of the upper part of the lower member of the Keeler Canyon formation of Pennsylvanian and Permian age close to the eastern contact of the stock of the Darwin Hills. The rocks consist of calc-hornfels, marble, and tactite that are metamorphosed equivalents of interbedded silty and sandy limestone, limy shale, and pure limestone. The metamorphosed zone extends about 3,000 feet east of the stock. The calc-hornfels is derived from limy shale and silty and sandy limestone. The relatively pure limestone beds are in part unmetamorphosed, but in most places they are recrystallized to marble or altered to tactite.

Calc-hornfels is the predominant rock type. It is a light-gray to greenish-gray dense rock with a wide range in mineralogy depending upon the original composition of the rock. In general, the calc-hornfels is composed of diopside and wollastonite with lesser amounts of garnet, oligoclase, scapolite, tremolite, and relict calcite. The pure limestone beds are partly recrystallized to a gray, medium-grained marble. Locally the marble and limestone are replaced by tactite within a few hundred feet of an intrusive contact close to the intersection of faults. Most of the tactite is a garnet- or idocrase-rich rock, but some contains epidote, diopside, wollastonite, and calcite. The garnet is andradite.

The eastern contact of the stock of the Darwin Hills is very irregular. Many small dikes and sills extend as far as 1,500 feet east of the main intrusive body, and the tungsten deposits are localized close to these offshoots. A group of dikes and small, irregular intrusions extend east of the main stock on the St. Charles claims. A sill of quartz monzonite is 160 feet east of the Durham glory hole, and an irregular intrusion crops out along the ridge between the Durham and Chipmunk mines (pl. 9).

The Paleozoic rocks have been tilted into an overturned section that strikes north and dips 30° to 78° W. as described under the subtopic "Geology" in the section on the Darwin lead-silver-zinc district. Numerous faults that strike N. 60° E. to east and dip steeply either north or south cut the rocks, but the displacement along the faults is small. Slickensides are nearly horizontal, and the displacement is predominantly left lateral.

Ore Bodies

Scheelite ore bodies are found as replacements of pure limestone and tactite beds close to the intersection with N. 70° E.-striking faults and within the N. 70° E. faults mostly where the wall rock is pure limestone or tactite. Most of the ore is found within 3 limestone beds locally known as the Durham, Frisco, and Alameda beds (pl. 9). Only the Durham ore body is known to extend more than 60 feet vertically (fig. 24). The Durham and Alameda ore bodies are replacements of pure limestone and tactite beds close to the intersections with the Fernando shear zone. The Durham ore body is a replacement of the footwall of the Durham limestone bed where it i contact with calc-hornfels. The ore body is expose 350 feet at the surface and has been mined to a dep 350 feet where the ore body is only 30 feet long (fig Its thickness ranges from 2½ to 35 feet.

Three ore bodies that are replacements of the Ala bed near N. 70° E. faults have been mined. Two a the intersection of the Alameda bed with the Ferr shear zone; the third is 1,000 feet northwest of the nando shear at the Alameda shaft. The largest of ore bodies is at the intersection of the Alameda bed the Fernando shear 950 feet S. 80° W. of the port the Fernando adit. It has been developed by an ope 50 feet long parallel to the strike of the enclosing stone, 60 feet wide, and about 20 feet deep. A drif being driven in 1955 under the pit to develop ore remained at the bottom.

The ore in the St. Charles-Hayward area is in N E. faults that dip steeply to the northwest (pl. 9) largest ore body is developed by the St. Charles workings (fig. 25). The ore shoot was 140 feet long 10 feet thick, and was mined from the surface average depth of about 30 feet. Most of the scheeli posed in the St. Charles No. 2 and St. Charles workings is in thin veins or streaks along N. 70 faults, and no scheelite is disseminated in the wall between faults (fig. 25). The streaks range from a tion of an inch to 6 inches thick and can be mined by highly selective methods or where fractures are ciently close that several can be mined together. So the streaks contain 10 to 30 percent WO_3, but the of ore over a mining width would probably average about 0.2 to 0.3 percent WO_3.

Grade

The grade of ore mined from the district has ave about 0.75 percent WO_3. Wilson (1943, p. 558) re that from 1941 to 1942 approximately 32,000 tons o averaging more than 1 percent WO_3 was mined fro Darwin Hills. The ore at the Durham mine avera percent WO_3 over an average width of 15 feet o 200-foot and 300-foot levels (Wilson, 1943, p. 558). grade of ore at the St. Charles No. 1 mine was hig ranged from 2 to 10 percent WO_3. Ore mined since averaged about 0.5 percent WO_3.

Submarginal ore is present at the Fernando min to a lesser extent at the St. Charles No. 3 mine. The marginal ore at the Fernando mine is exposed i main Fernando adit along the Fernando shear zone 24). Scheelite is localized along fractures over a le of 610 feet and a width up to 50 feet; some parts o area are estimated to contain 0.2 to 0.5 percent WO

Ore Controls

The ore controls for scheelite are both stratigr and structural. Pure limestone, and tactite formed alteration of it, are more favorable for ore than calc-hornfels. However, the dense calc-hornfels cann eliminated as a possible host rock as some ore has mined from it. The bedded replacement body at the ham mine selectively replaced tactite and pure limes Most other occurrences of scheelite in the distric along N. 70° E.-striking faults, and scheelite ma t whether the wall rock is tactite, limestone, or ornfels. Commonly the scheelite zone is widest a fault cuts tactite and thins to a narrow stringer the fault cuts calc-hornfels. In both the St. Charles workings and in the Hayward mine, ore has been from veins where the wall rock is calc-hornfels. At ayward mine the ore is widest where the wall rock ite, and the vein thins to a thin stringer to the east the wall rock is calc-hornfels. The ore body rakes west parallel with bedding.

nitic rocks must be close by in order to form either or scheelite. The most favorable places for ore are small satellitic intrusive bodies crosscut structure. ctite and scheelite do not necessarily form adjacent intrusive rocks, but are within a few hundred feet rusive rocks and commonly are localized by faults.

neralogy

primary tungsten ore contains scheelite in a e of andradite, calcite, fluorite, idocrase, and py- Bismuthinite is present at the Fernando mine. the wall rock is hornfels, wollastonite and diop- re common. At the Thompson mine the scheelite is ated with galena, sphalerite, pyrite, chalcopyrite, e, and calcite in light-colored calc-hornfels com- of idocrase, garnet, wollastonite, diopside, and e.

scheelite is commonly in euhedral crystals as much ches in diameter. At the Thompson mine, euhedral hedral crystals of scheelite predominantly three- s to three-fourths inch in diameter are surrounded places veined and slightly corroded by sulfide als. Davis and Peterson (1948, p. 2) described ral scheelite crystals in a powdery matrix of limon- rosite, and clay minerals from the oxidized ore in ompson mine. At the Durham, Fernando, and St. es mines galena and sphalerite are only in small ts in tungsten ore bodies, but they occur elsewhere the same ore controlling structures farther from ck of the Darwin Hills.

Durham ore body contains bismuthinite and py- ear the intersection of the Durham bed with the ndo shear zone. The bismuthinite is in tabular ls as much as 2 inches long in calcite veinlets that e tactite. It is mostly pseudomorphously replaced ht green powdery bismutite. The tungsten ore from the Durham ore body had an average bis- metal content of approximately 0.05 percent, but muth was recovered.

t of the ore is oxidized and consists of euhedral to dral crystals and grains of scheelite in a crumbly of limonite, calcite, and partially decomposed licate minerals. Chrysocolla, azurite, malachite, ypsum coat some of the fractures. Bismuthinite at ernando mine is nearly completely altered to bis- . The scheelite in the upper stopes of the Thomp- ine is embedded in a crumbly matrix of limonite, e, cerussite, and clay minerals. The scheelite re- d essentially inert to the meteoric waters, although other minerals were oxidized or partly leached; he ore has undergone some residual enrichment of en.

Alameda Mine

The Alameda mine is 4,200 feet N. 80° E. of Darwin in sec. 19, T. 19 S., R. 41 E., at an altitude of 5,000 feet. The property was originally developed as a copper prospect by Charles Richardson in the early 1900's and he sunk an inclined shaft 103 feet deep (Aubury, 1908, p. 313). Very little drifting or crosscutting were done.

A pocket of scheelite ore was reported in the shaft at a depth of 95 feet by Wilson (1943, p. 557). This pocket was mined by the Pacific Tungsten Company during World War II, and an additional small tonnage was mined in 1953 by W. E. Schmidt who had a sublease on the property from Howard Miller and Louis Warnken, Jr. The total tonnage of tungsten ore mined is small, because the stope at the bottom of the shaft is only about 25 feet long, 6 to 10 feet wide, and 9 feet high.

The rocks in the mine area are marble, calc-hornfels, and tactite of the Keeler Canyon formation and are intruded 290 feet west of the inclined shaft by the stock of the Darwin Hills. Bedding strikes N. 18° W. and dips 71° SW. The shaft is sunk in marble on a bedding-plane vein 3 feet thick. The vein contains a small amount of secondary copper minerals in a gangue of calcite and limonite. Scheelite has been mined from a small stope at the bottom of the shaft where the N. 18° W. vein is intersected by a small fault that strikes N. 20° E. and dips 77° SE. Only a small amount of scheelite remains along the cross fault.

Bruce Mine

The Bruce mine is 6,000 feet N. 28° E. of Darwin in sec. 18, T. 19 S., R. 41 E., on the north side of Lane Canyon at an altitude of 4,800 feet. A steep dirt road leads to the property from the road in Lane Canyon. The mine is owned by The Anaconda Company and was leased to A. J. Pouch and "Frenchie" Lingsley of Darwin in 1955. The workings consist of 2 adits about 80 and 100 feet long and an open cut 50 feet long, 10 feet wide, and 5 to 15 feet deep.

The rocks in the mine area are calc-hornfels and tactite that are folded into an open anticlinal-shaped fold that is an inverted syncline. The fold axis is approximately 350 feet east of the stock of the Darwin Hills. The rocks are correlated with the upper part of the lower unit of the Keeler Canyon formation of Pennsylvanian and Permian age. The crest of the anticline is mineralized along the surface for a distance of about 400 feet. In the open cut the vein is 2 to 6 feet thick along the crest of the anticline, and ore extends down the west limb of the anticline as a bedding-plane vein that strikes N. 25° W. and dips 67° SW. The vein contains calcite, quartz, limonite, chrysocolla, cuprite, malachite, garnet, and scheelite. The grade or continuity of the deposit down the dip is not known because of insufficient development. Samples cut by D. L. Davis on surface exposures averaged 0.40 percent WO_3 and approximately 1 percent copper; the vein shows only scattered ore minerals where cut by the lower adit.

Chipmunk Claim

The Chipmunk claim, owned by W. E. McCully of Darwin, is 6,000 feet S. 75° E. of Darwin in sec. 19, T. 19 S., R. 41 E., at an altitude of 4,700 feet. The claim is 850 feet S. 15° W. of the Durham open cut. A dirt road that branches off from the Durham road leads south to the property. Mine workings consist of an adit 115 feet long and several open cuts and short adits.

The rocks in the mine area are calc-hornfels and tactite that are correlated with the top of the lower member of the Keeler Canyon formation. Overturned bedding strikes north and dips 65° to 80° W. A steep fault that strikes N. 70° E. cuts through the portal of the main adit, which trends S. 15° W. along another steep fault.

Scheelite is exposed along the N. 70° E. fault for a distance of 70 feet. Only a few specks of scheelite were seen in the adit along the steep N. 15° E.-striking fault.

Darwin Group

Some of the lead-silver stopes of the Thompson workings have local concentrations of scheelite, although most of the ore contains no scheelite. Davis and Peterson (1948, p. 2) report several hundred tons of lead-silver ore containing 10 to 15 percent WO_3 was mined from oxidized ore. Euhedral crystals of scheelite are found loosely embedded in a matrix of cerussite, limonite, jarosite, gypsum, and wulfenite. Primary ore has also been found in the deeper levels that contain euhedral crystals of scheelite surrounded and slightly embayed by galena (photo 1). Small amounts of scheelite are in fractures in or near the Water Tank fault near the crest of the ridge east of the Darwin mining camp and on the Bernon claim (pl. 5). All are too low grade to be ore.

Durham Mine

The Durham mine is 5,500 feet east of Darwin in sec. 19, T. 19 S., R. 41 E., at an altitude of 4,640 feet. The property is accessible by a hard-surfaced road leading south from Lane mill. Development work consists of an inclined shaft 250 feet deep with 4 levels totaling 1,100 feet of drifts and crosscuts (fig. 24). The 100-foot level connects with the bottom of the Fernando shaft.

The rocks in the mine area consist of limestone, marble, calc-hornfels, and tactite of the Keeler Canyon formation and are intruded by a sill of quartz monzonite 170 feet east of the Durham shaft. Overturned bedding strikes north and dips 50° to 67° W. The rocks are intersected by a series of strike-slip faults that trend east to N. 70° E.

The ore body extends south from the Fernando shear along the footwall of a limestone bed 40 feet thick that is in part recrystallized to marble and altered to an idocrase- and garnet-rich tactite. The tactite is in the basal part of the limestone bed in the upper mine workings and in the central part of the bed below the 200-foot level. Many small cross fractures cut the limestone and tactite.

The ore body is 350 feet long at the surface, and the ore mined by the Pacific Tungsten Company in 1941 to 1943 ranged in thickness from 4 to 20 feet. The lower grade wall rock has been mined by subsequent lessors so that the glory hole now has a maximum width of 44 feet. The ore body extended to a depth of 350 feet (fig. 24). On the 0 and 100 levels, the best grade of ore is on the footwall of the limestone bed where it is altered to tactite. On the 200-foot and 300-foot levels the footwall is barren, and the ore is in the middle of the limestone and tactite bed.

Scheelite occurs irregularly through much of th tite, but the mineralization is more intense where fractures are abundant, and scheelite extends out the main ore body into tactite along these cross frac

Fernando Mine

The Fernando mine consists of two patented c that lie adjacent to the Durham mine on the north both properties are accessible by the same road. Th mines have been worked as a unit through intercoı ing workings. The Fernando mine was worked orig for its lead-silver values. The old workings are 50 N. 70° E. of the portal of the Fernando adit, and consist of an inclined shaft 125 feet deep paral bedding and several levels driven from the shaft. F (1938, p. 561) reports that on the 100-foot level mi ization along the Fernando shear zone is 30 to 4(wide and the ore consists of galena, cerussite, and a site in a gangue of limonite, calcite, and jasper. The recorded production of lead-silver ore was in 191 1920 when the mine was operated by Theo Peterson

The tungsten ore is along the Fernando shear zon feet S. 70° W. of the old Fernando workings. The zone is prospected and developed by three adits. Fernando or zero level totals 1,850 feet of drifts crosscuts, and a winze extends 40 feet below this The intermediate level, 230 feet above the zero level the Alameda glory hole have 310 feet of drifts and cuts. An inclined shaft 130 feet deep near the port the Fernando adit connects with the 100-foot level c Durham mine.

Tungsten ore in the Fernando mine is of low g and it has been worked successfully only by sel mining and sorting or by screening. Scheelite is er ally distributed along fractures in the Fernando zone, which strikes east and dips steeply south, b is not sufficiently abundant to be ore except at the i sections of the Fernando shear with pure limesto tactite beds. The largest ore shoot was mined fro open cut at the intersection of the Alameda bed an Fernando shear zone. The ore shoot was 90 feet parallel to bedding, 46 feet wide, and was mined depth of 50 feet.

Considerable prospecting has been done on the level along the Frisco bed, but only a small amou ore was found. A winze was sunk on ore on the F bed to a depth of 40 feet along a fracture that st N. 70° E. and dips 55° SE. On the zero level th shoot is 55 feet long and 2 to 10 feet thick, but scheelite is exposed at the bottom of the winze (se 24). Low-grade ore containing less than half a pe WO_3 is within the Fernando shear zone at its interse with the Frisco bed (fig. 24). Low-grade scheelite exposed for 200 feet and is a few inches to 15 feet t The vertical extent has not been prospected. A stringer of scheelite is exposed in the crosscut or Frisco bed 340 feet south of the Fernando shear. scheelite stringer is 1 inch to 6 inches thick along a ture that strikes N. 77° W. and dips 66° SW. No c cutting has been done along the fracture. Some ore mined at the portal of the Fernando adit near the i section with the Durham bed, but no ore was four a downward extension in the Fernando shaft.

Hayward Mine

he Hayward mine is 1 mile N. 78° E. of Darwin in 19, T. 19 S., R. 41 E., 300 feet east of the portal of St. Charles No. 1 adit. The mine is accessible by a road down the canyon past the St. Charles mine. elopment work consists of an open pit 50 feet long, eet wide, and 20 feet deep. A 50-foot vertical shaft sunk at the east end of the open pit.

he ore consists of many narrow seams of scheelite g fractures in a shear zone striking N. 65° E. and ping 72° SE. in dense hornfels. The size of the ore y is outlined by the dimensions of the pit. The fault extends northeast onto the Custer claim where it been prospected by a vertical shaft 50 feet deep that 40 feet N. 74° E. of the Hayward open pit. Only a row seam of scheelite is exposed in the vertical shaft.

everal shallow shafts and open cuts have been dug a fault zone 200 feet south of the fault through the ward open pit. The fault zone is 3 to 4 feet thick contains minor scheelite and secondary copper mins. In 1955 an adit was being driven to prospect the t zone at a depth of about 50 feet.

Lane Mine

ome scheelite is exposed in the Lane mine 700 to 800 within the portal of the Lane adit, and a raise was en 70 feet above the level by the Imperial Metals npany to explore the scheelite-bearing zone. The elite is in hornfels along fractures in a fault zone strikes N. 72° E. The U. S. Bureau of Mines saml the raise and the adit at 10-foot intervals from 633 70 feet from the portal between Nov. 17, 1941, and . 19, 1942 (Butner, 1949, p. 6). Thirteen samples g the adit assayed a trace of WO_3 and one sample yed 0.09 percent WO_3. Four samples were taken in raise. Two assayed a trace of WO_3, one assayed 0.49 cent WO_3 over a width of 5.5 feet, and one 0.8 per- WO_3 over a width of 4.7 feet.

St. Charles Mine

he St. Charles mine is 4,500 feet N. 72° E. of Darwin ec. 19, T. 19 S., R. 41 E., at an altitude of 4,750 feet. mine is southwest of the Custer mine. Three areas prospected by separate workings known as the St. rles No. 1, No. 2, and No. 3 workings (fig. 25). The Charles No. 1 area is developed by an inclined shaft feet deep and by 662 feet of drifts and crosscuts. St. Charles No. 2 workings, which are 280 feet north he St. Charles shaft, consist of an adit 97 feet long n two short crosscuts; the No. 3 workings 230 feet 15° W. of the St. Charles shaft consist of three unnected adits with several short crosscuts, all of which l 600 feet in length.

he rocks in the mine area are interbedded calc-horn- and pure limestone beds that are in part recrystall to marble and altered to tactite. They are correlated n the lower member of the Keeler Canyon formation Pennsylvanian and Permian age. Overturned bedding he metasedimentary rocks strikes N. 30° W. and dips SW. Many steep faults that strike N. 60°-70° E. cut rocks. A granodiorite dike that is an offshoot of the rwin stock is 100 feet northwest of the St. Charles 1 shaft.

The ore body in the St. Charles No. 1 workings is in a vein that strikes N. 65° E. and dips 70° NW (fig. 25). The ore shoot was 140 feet long and 2 to 10 feet thick; it was mined from the surface to an average depth of 30 feet. The ore extended only 10 to 15 feet below the adit level, and the bottom 105 feet of the shaft is in submarginal ore or barren rock. The ore from the stope averaged 2 to 8 percent WO_3. The scheelite was localized in two narrow high-grade veins separated by 5 to 8 feet of low-grade ore. Southwest of the ore shoot the 2 high-grade veins diverged to a horizontal separation of 20 feet, and the amount of scheelite in each vein decreases. Some ore has been mined from the northernmost split for a stope length of 35 feet, a width of 3 to 4 feet, and for a maximum distance of 55 feet down the dip. Work was being done in this part of the mine in March 1955.

At the St. Charles No. 2 workings, scheelite is exposed in the adit 50 feet from the portal, along fractures trending N. 65° E., but the showings are thin and low grade (fig. 25).

At least three veins have been prospected in the St. Charles No. 3 workings, but ore was mined only from the lowest adit. Thin seams of scheelite are exposed in many places in the lowest adit in fractures trending N. 65° E., but only two small shoots have been mined. A high-grade seam of scheelite 40 feet long and a maximum of 6 inches thick was mined between 25 and 65 feet within the adit, and a raise has been driven to the surface on a shoot of ore 10 feet long in the same structure 90 feet within the adit. At 65 feet within the portal 2 thin seams of high-grade scheelite are exposed, but the hornfels between seams is barren, making the average grade over a mining width of 3 feet less than 0.3 percent WO_3. The 2 upper adits exposed only a small amount of scheelite in thin fractures and none is of ore grade.

Toga Mine

The Toga mine is 4,500 feet S. 82° E. of Darwin in sec. 19, T. 19 S., R. 41 E., along the crest of the ridge overlooking Darwin Wash (pl. 9). The property is accessible by a road from Darwin. The C. W. Fletcher estate owns the mine.

The property is developed by several short adits and raises to the crest of the ridge at the end of the road to the Toga mine and by an adit 370 feet long that was driven from the gully 270 feet east of the raises. Some scheelite was mined by Fletcher in 1943 from the workings along the crest of the ridge.

The rocks in the mine area are limestone and calc-hornfels of the lower member of the Keeler Canyon formation and quartz monzonite of the stock of the Darwin Hills. The stock crops out 60 feet southwest of the workings at the crest of the hill and a dike offshoot from the stock is 60 feet to the east. The mine workings intersect a fault that strikes N. 70° E. and dips 80° SE.

A small scheelite ore body was mined from the workings at the crest of the hill. The ore was localized in the N. 70° E. fault at the intersection with one of the Alameda limestone beds. The fault zone is 8 feet thick in the mine area and locally contains scheelite in a highly limonitic groundmass. Scattered scheelite is exposed in the fault zone in the 390-foot adit on the property.

Deposits in the Coso Range

A few small tungsten deposits are on the northeast slope of the Coso Range 8 to 10 miles southwest of Darwin. Most of the deposits are south of the Darwin quadrangle, and only the Lone Pinyon prospect, which is near Black Springs, lies within the quadrangle and is described here. The deposits are within roof pendants or screens of metasedimentary rocks in quartz monzonite of the batholith of the Coso Range. None have proved to be extensive.

Lone Pinyon (Black Rock) Prospect

The Lone Pinyon prospect is in the Coso Range 8 miles S. 80° W. of Darwin and 2,400 feet east of Black Springs in the SW¼ sec. 26, T. 19 S., R. 39 E., at an altitude of 6,200 feet. The prospect is accessible from Darwin by a dirt road that crosses Lower Centennial Flat. Clyde E. Hanbury and associates developed the property in 1941 and 1942. Little or no work has been done since then. The property is opened by an adit 140 feet long bearing S. 31° W. and a few surface pits and trenches. D. M. Lemmon and J. H. Wiese of the U. S. Geological Survey mapped the property in February 1942 and most of the data here are from their investigations.

Quartz monzonite is the predominant rock type in the mine area. It contains many small screens or roof pendants of limestone that are in part altered to tactite and calc-hornfels. The main tungsten showings are in a screen that is 100 feet long in a N. 30° E. direction and 30 feet wide that has been prospected by the adit. Bedding strikes N. 80° E. and dips 50° SE.

Scheelite-bearing tactite crops out at the surface 100 feet S. 30° W. of the adit portal and 60 feet higher at the contact with quartz monzonite over an area 20 feet long and 10 feet wide. The ore did not extend to the adit.

For the first 40 feet the adit is in tactite that contains a small amount of scheelite. The tactite is composed of garnet, epidote, calcite, limonite, and quartz. The remainder of the adit is in hornfels and marble with only a few narrow streaks of scheelite-bearing tactite.

Antimony Deposits

Darwin Antimony Mine

The Darwin Antimony mine is in the Darwin Hills 2 miles north of Darwin in sec. 2, T. 19 S., R. 40 E. The mine is on one of three unpatented claims located in 1942 by F. E. Groover of Balboa, Calif. The production of antimony from the mine is reported by Norman and Stewart (1951, p. 29) as, "50 to 100 tons of ore assaying more than 30 percent antimony." The workings consist of shafts, drifts, and crosscuts totaling 550 feet. The lower shaft, reported by Norman and Stewart (1951, p. 29) to be 100 feet deep with 50 feet of crosscuts east and west from the bottom, is inaccessible. The shaft has an inclination of 65° W. The upper or main shaft, about 350 feet due north and 68 feet higher at the collar, is 150 feet deep and has an inclination of 65° in a S. 78° W. direction. At the 100-foot level, 12-foot drifts extend north and south from the shaft. At the bottom of the shaft, 50-foot drifts extend north and south. From the south end of the south drift, crosscuts extend 50 feet west and 30 feet east. A stope in the east crosscut produced all the antimony ore shipped from the mine.

The Darwin Antimony mine area is underlain by bedded medium-gray limestone of the lower membe the Keeler Canyon formation of Pennsylvanian and mian age, which is about 1,000 feet thick, in the vici of the mine. Bedding in the Keeler Canyon formati overturned. It strikes north at the main shaft and 62° to 65° W. The limestone is sheared and fract near the main shaft, and limonite and calcite fill n of the fractures. A bedding-plane fault that strikes n and dips 65° W. is exposed in the main shaft. It is off by the Darwin tear fault at the position of the l shaft.

Ore in the Darwin Antimony mine is localized a the bedding-plane fault exposed in the main shaft. fault is traceable along strike for about 1,000 feet. nite is exposed intermittently at the surface and in underground workings over a strike length of about feet near the main shaft and probably was in the l shaft 350 feet farther south. The vein consists of stib with minor secondary antimony minerals in she limestone. Limonite and calcite are the chief gar minerals. The vein ranges in thickness from a few in to about 3 feet. All the ore was mined from a stop the footwall between the 100- and 150-foot levels a 40 feet south of the main shaft. Small discontin seams and pods of stibnite less than an inch thick exposed in the north drifts on the 100- and 150- levels.

Many other bedding-plane faults, also having a n strike, are exposed in the west crosscut, but are not eralized. Several faults with approximate N. 60° strikes and steep northwest dips intersect the main no trending fault in the east crosscut of the 150-foot l and are mineralized at some of these intersections.

At least three shallow prospect pits were cut into vein at the surface not more than 100 feet north of main shaft, but no ore was produced from them.

Copper Deposits

Copper minerals are associated with practically al the lead-silver-zinc ores and with some of the schee deposits. In a few deposits copper minerals are principal ore mineral, and only these deposits will described here. The deposits are the Giroux mine adjacent prospects near Darwin and the Whipper prospect near the east border of the quadrangle (pl. Mines of the Darwin group account for most of the per production in the quadrangle, but the Santa R Lane, and Custer mines also produced some copper.

Mining activity on the copper prospects was mo confined to the late 1890's and the first few years of century. Most of the deposits are described by Aub (1902, 1908). A blast furnace was built at the Lane m in 1898, and some copper matte was recovered (War and Huguenin, 1919, p. 99).

Geology

Copper minerals are in the lead-silver-zinc depo and locally along fractures in some tactites. Most of copper minerals are in oxidized ore. Chrysocolla is prevalent copper mineral—occurring in almost ev copper-bearing deposit. Antlerite, aurichalcite, azur brochantite, caledonite, chalcanthite, cuprite, linar malachite, and tenorite are the less common second er minerals found in the quadrangle. The primary er minerals are chalcopyrite, enargite(?), tetrahe-, and tennantite. Small amounts of supergene chalco- and covellite are also present.

x (Jeroo, Rio Tinto) Mine

e Giroux mine, which is owned by the C. W. her estate, is in sec. 24, T. 19 S., R. 40 E., about a mile east of the town of Darwin. The main mine ings consist of a lagged two-compartment vertical 203 feet deep with a 95-foot crosscut and a 70-foot shaft inclined 42° SE. about 150 feet S. 32° E. of main shaft. Most of the workings were made prior 08 when the mine was owned by Joseph Giroux of Angeles (Aubury, 1908, p. 313). No production data available.

e mine is along a contact between iron stained onic rocks of the stock of the Darwin Hills to the heast and calc-hornfels of the Keeler Canyon forma- to the southwest. A garnet-rich tactite zone 1 foot feet thick is locally along the contact. The workings lop small oxidized veins and irregular iron stained s. A 2-foot thick vein explored by the inclined shaft es N. 55° W. and dips 42° SW. parallel to bedding e calc-hornfels. Minor cross fractures cut this vein cause negligible offsets. Another vein is exposed in a bout 50 feet S. 43° W. of the main shaft. This vein es N. 80° W. and dips 40° SW. It is 3 feet thick and be traced for 30 feet on the surface.

e ore minerals consist of secondary copper minerals, ly chrysocolla, with minor cuprite, and malachite. veins are heavily iron stained and limonite pseudo- phous after pyrite pyritohedrons are abundant. Au- (1902, p. 245) reports chalcopyrite and minor nts of gold and silver in the ore.

man Prospect

e old Kingman copper prospect is in sec. 19, T. 19 R. 41 E., about 1,000 feet S. 66° E. of the Giroux . Workings consist of 2 adits each about 100 feet that trend S. 5° W. and an open pit 40 feet long, ximum of 20 feet wide, and 20 feet deep. The pros- is in calc-hornfels and tactite of the Keeler Canyon ation near the contact with the stock of the Darwin . Copper minerals are in two iron stained veins 1 to 4 feet thick and in smaller quantities as fracture ngs in tactite. One of the veins strikes N. 20° W. dips 70° NE., and the other strikes N. 85° E. and 75° SE. The prevalent copper mineral is chrysocolla some cuprite, malachite, and aurichalcite(?). Au- (1902, p. 245) reports chalcopyrite and small nts of gold and silver.

perwill Prospect

e Whipperwill prospect is in sec. 35 (projected), 7 S., R. 41 E., in a canyon near the eastern border e quadrangle. Workings consist of an inclined shaft t 40 feet deep and short drifts. Copper minerals are ized in a shear zone 6 to 20 feet thick that cuts the hornfels and tactite country rock. The shear zone es N. 20° W. and dips 70° SW., approximately llel to bedding. The shear zone contains chrysocolla gangue of sheared, iron-stained calc-silicate min- s.

Gold Prospects

Gold prospects are distributed through the granitic rocks in the southwestern part of the quadrangle, particularly in the low rolling hills west of the Darwin Hills (pl. 1). A few prospects are in the extreme northwestern part of the quadrangle, the southern part of the Santa Rosa Hills, and in the Argus Range. The prospects are all small, and it is doubtful if any produced more than a few tons of ore. Most of them were located during the 1930's and show little indication of recent work.

The numerous prospects in the low hills west of Darwin and those in the northern part of the Coso Range are on iron-stained and local quartz-rich fractures cutting granitic rocks of the batholith of the Coso Range. The fractures strike about N. 30° W. and dip steeply. They can be traced for as much as several hundred feet. Commonly the fractures are tight and locally contain small quartz lenses and veins a maximum of 1 foot thick. Most of the quartz veins and lenses are iron-stained and contain minor amounts of calcite, pyrite, and secondary copper minerals. No gold was seen.

The prospects in the northwest part of the quadrangle are in the shale member of the Owens Valley formation. They explore small gash veins filled with coarsely crystalline quartz. The veins are 10 to 30 feet long and a few inches thick. Shallow workings for gold in the southern part of the Santa Rosa Hills are on northwest-trending, steeply dipping mineralized faults cutting Mississippian limestone. The principal workings are on the West vein at the Lee mine on an iron-stained quartz-calcite vein (pl. 8). At the Granite claim in the Argus Range a short adit follows a steeply dipping fracture in quartz monzonite that locally contains quartz.

Nonmetallic Commodities

Nonmetallic commodities include talc, light-green chlorite which is locally called "pyrophyllite," limestone, dolomite, and quartzite. Only talc and "pyrophyllite" are important commercially at present. The great distance to marketing centers is the chief factor inhibiting the development of the vast quantity of limestone and dolomite.

Talc Deposits

Talc deposits are confined to Devonian and older rocks in the Talc City Hills (pl. 2). Only a brief description of the deposits is given here as the deposits are described by Page (1951) and the reader is referred to his report for detailed mine descriptions. Gay and Wright (1954, map sheet no. 12) mapped the surface geology of the Talc City Hills Mines in the Talc City Hills have been one of the nation's major sources of steatite-grade talc, but in recent years production has been small. The Sierra Talc and Clay Company owns most of the large mines.

The Talc City Hills are underlain by sedimentary rocks of Early Ordovician to Permian age and Cretaceous quartz monzonite. The Silurian and Ordovician sedimentary rocks are predominantly dolomite; the Mississippian and younger rocks are predominantly limestone. The older part of the Devonian rocks is predominantly dolomite and the younger part is limestone and shale.

The Devonian and older rocks are thrust over younger Paleozoic rocks. The Devonian and older rocks in the thrust plate are tightly folded and cut by many steep faults. Overturned bedding and inverted structures are common.

Geology

The talc deposits are replacements of dolomite and quartzite near or within shear zones peripheral to the stock of the Talc City Hills. Dolomite of the Lost Burro formation is the principal host rock for talc, but deposits are also in quartzite and dolomite of pre-Devonian age. Some talc has replaced felsite dikes and sills in the Frisco mine. No deposits are in limestone. Most of the dolomite is normal in the regional stratigraphic section, but some dolomitized limestone is present locally near most of the mines. The dolomite is recrystallized and nearly all evidence of original bedding has been obliterated so that original dolomite does not look like its analogue in unaltered equivalent sections. The prevalent talc-controlling shears strike northwesterly and dip nearly vertically.

The steatite is grayish green, pale green, or dull white. It commonly is highly sheared. The larger steatite deposits are irregular elongate pods as much as 600 feet long and 50 feet thick. Most of the deposits are small irregularly shaped bodies a few inches to a few feet thick and are exposed for 10 to 20 feet along shear zones. Some of the deposits contain large residual masses of the host rock.

Except for a few thin dikes and sills of felsite the nearest intrusive rock is quartz monzonite of the stock which crops out in the southern part of the Talc City Hills. The deposits near the stock are larger than those farther away from the stock.

Alliance Mine

The Alliance mine is in secs. 29 and 30 (projected), T. 18 S., R. 40 E., at an altitude of 5,400 feet. Edith Lockhart and George Koest, mailing address Darwin, Calif., own the mine. The main workings consist of a northeast-trending glory hole about 200 feet long, 50 feet in maximum width, and 30 feet in maximum depth, an inclined shaft 70 feet deep that connects with about 500 feet of level underground workings and stopes, and several minor adits and pits. Page (1951, p. 12) reports a total production between 5,000 and 10,000 tons.

The talc deposits are in or near shear zones in dolomite and quartzite of Ordovician and Silurian age. The dolomite and quartzite are thrust over limestone of Pennsylvanian and Permian age; the thrust contact is exposed at the south end of the mine (photo 8). Locally the contact is steep on the Irish lease. Here, the thrust is apparently displaced a small amount by a later steep fault. The main workings are on a N. 70° E.-trending shear that dips about 47° NW. Eureka quartzite is in the footwall of the shear and Hidden Valley dolomite in the hanging wall. Talc is in an alteration zone as much as 30 feet thick that can be traced about 200 feet. Much of the material of this zone is a dark-gray chloritic rock, but talc is in irregularly shaped bodies in gradational contact with the chlorite. According to Page (1951, p. 22) two types of talc were mined—a white to gray, commonly mottled talc and a dark-gray to black talc.

The easternmost workings are on a shear zone 4 fe thick that strikes N. 48° E. and dips 75° NW. The ho rock is dark-gray Ely Springs dolomite. Talc is main on the hanging wall of the shear zone.

Apex Prospect

The Apex talc prospect is in sec. 29 (projected), T. S., R. 40 E., bordering the Talc City mine on the nort east. Talc occurs locally along a N. 80° E.-striki vertical shear zone and along a north-striking vertic shear zone, which is developed by a 40-foot shaft and a adit 100 feet long. The country rock is light-gray dol mite and minor bluish-gray limestone of the Lost Burr formation.

Bobcat Claims

The Bobcat claims are in secs. 29 and 32 (projected T. 18 S., R. 40 E., in the eastern part of the Talc Cit Hills. Talc is along two near-vertical shear zones. Th major zone strikes N. 75° W. and the other N. 25° I Page (1951, p. 30) reports the ore body, which is no mined out, was more than 100 feet long and was 5 to 1 feet thick. The host rock is light-gray dolomite of th Lost Burro formation. Blue-gray limestone of the Los Burro formation crops out south of the northwest-trend ing shear zone.

Frisco Mine

The Frisco mine is 4,000 feet southwest of the Tal City mine in sec. 31 (projected), T. 18 S., R. 40 E. Th mine is owned by the Sierra Talc and Clay Compan The deposit is developed by two inclined shafts 60 an 65 feet deep and three pits, the largest approximatel 350 feet long, 100 feet wide, and 50 feet deep. Ligh medium gray dolomite of the Pogonip group is the prir cipal host rock. Gray limestone of the Pogonip is ex posed in parts of the mine area but does not serve as host for the talc. Some sills and dikes of chloritize felsite are exposed in one of the pits. Slivers of quartzit locally distributed in the shear zones are believed to b Eureka quartzite fault-dragged into the Pogonip. Al though the mine produced significant quantities of steat ite, a large part of the production consisted of massiv green chlorite, locally called "pyrophyllite."

The easternmost inclined shaft and two of the larg open pits are on a chlorite-rich shear zone that strike N. 20° E. and dips 70° NW. Chlorite is abundantly ex posed in the largest pit along near-vertical shear zone 2 to 15 feet thick striking N. 70° W. and N. 20° E. Pag (1951, p. 30) gives the chemical analysis of the chlorit as follows:

	Percent
SiO_2	36.24
Fe_2O_3	1.19
Al_2O_3	23.56
MgO	23.39
Alkalies	0.35
CaO	1.47
Ig. loss	12.19
CO_2	0.86
Moisture	0.18
	99.43

The identification of chlorite was confirmed by a x-ray defraction pattern.

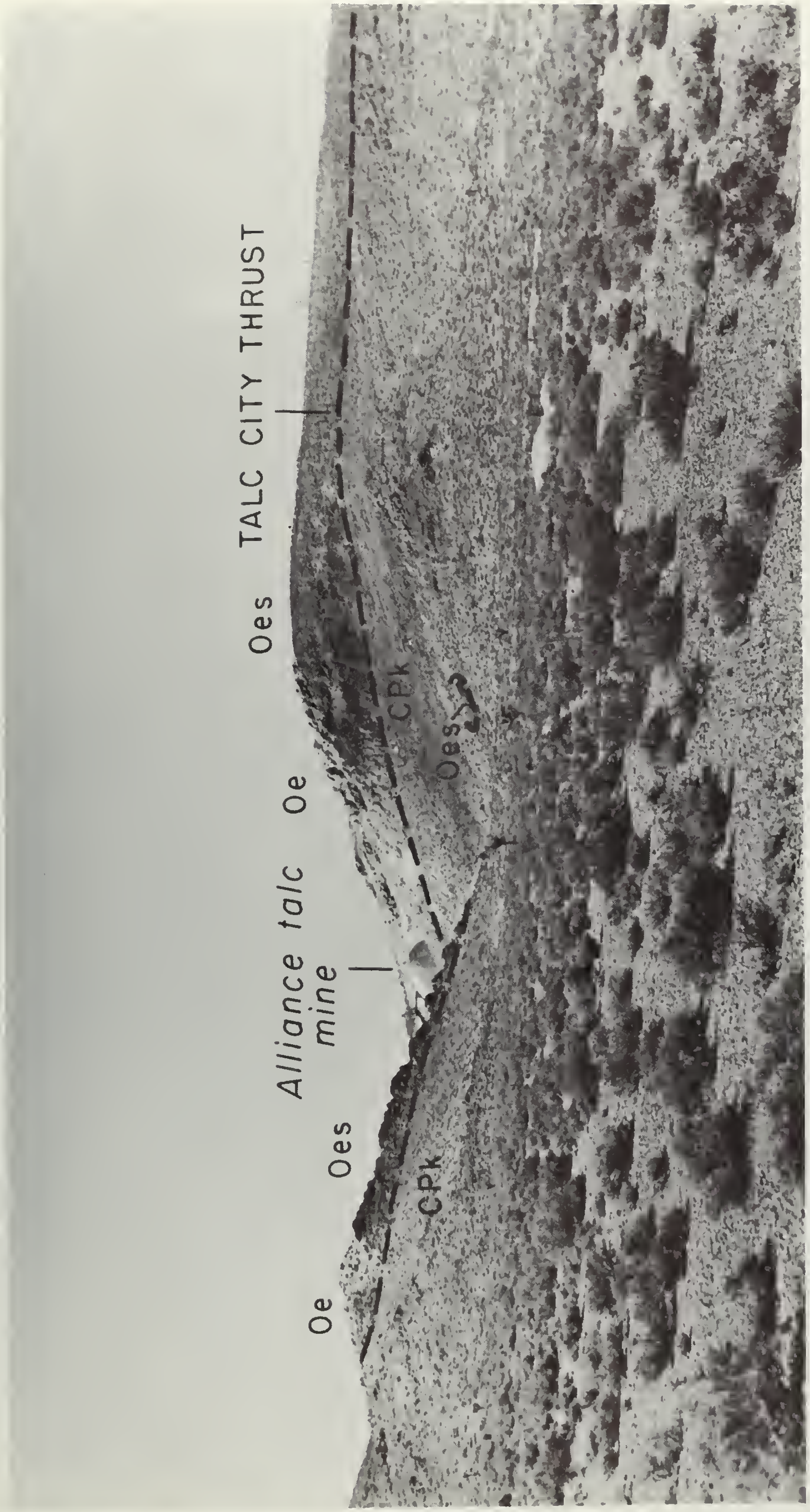


PHOTO 8. View looking north at the Alliance talc mine showing the Talc City thrust with the Eureka quartzite (Oe) and Ely Springs dolomite (Oes) of Ordovician age thrust over the Keeler Canyon formation of Pennsylvanian and Permian age (CPk).

PHOTO 9. Talc City mine. Talc is in shear zones in massive dolomite of the Lost Burro formation of Devonian age.

'he westernmost shaft and smaller pits are on a N. 70° rending shear zone that dips 70° NW. Talc bodies 5 5 feet thick are distributed locally along this shear. adit north of the western-most shaft is along a shear e 6 to 8 feet thick striking N. 75° W. and dipping SW. that contains a zone of chlorite 2 feet thick.

Hard Scramble Prospect

'he Hard Scramble prospect is in sec. 13 (projected), .8 S., R. 39 E. Talc is sporadically distributed along ıear zone that strikes N. 10° W. and dips 70° NE. shear is developed by an inclined shaft about 60 feet ɔ and by some short adits. The country rock is mainly ·eka quartzite and the talc formed as a replacement ıuartzite adjacent to Ely Springs dolomite.

Irish Lease

he Irish lease is in secs. 29 and 30 (projected), T. 3., R. 40 E., adjoining the southern boundary of the ance mine. Workings consisting of a short adit and nclined shaft about 65 feet deep are on a shear zone ‹ing N. 63° W. and dipping to the north. The shear e ranges from 4 to 30 feet thick and separates Eureka rtzite to the north from silty limestone of the Keeler yon formation to the south. Talc is in irregular ses within the sheared and altered rock. Page (1951, 2) reports the talc-bearing zone is at least 250 feet ; and that the talc replaced a quartzose rock—the eka quartzite.

Talc City Mine

he Talc City mine is in secs. 29 and 32 (projected), .8 S., R. 40 E. (pl. 2). The mine is owned by the ra Talc and Clay Company and has been the largest 'le source of steatite-grade talc in the United States. e production from the Talc City mine from 1915 to 7 is shown below. This table, which may include some luction from the Trinity mine, was compiled by the fornia State Division of Mines.

he extensive mine workings consist of three large y holes, several thousand feet of underground level kings, stopes, several shafts, inclined underground kings, and numerous shallow surface workings (photo Many of the underground workings are caved, and large open fractures are visible at many places on the surface.

*Table 13. Talc produced from the Talc City mine.**

Year	Short tons	Year	Short tons
	300	1932	4,398 (est.)
	428	1933	3,402
	620	1934	3,640
	2,000	1935	3,766
	3,398	1936	6,667
	7,087	1937	9,829
	4,300	1938	8,800
	5,325	1939	7,640
	5,685	1940	9,691
	5,202	1941	5,890
	4,517	1942	12,600
	5,462	1943	15,526
	5,273	1944	13,325
	6,195	1945	14,908
	6,370	1946	11,113
	5,561	1947	15,169
	4,398		

luction figures furnished by California State Division of Mines and published with e permission of the Sierra Talc and Clay Company.

The mine area is in highly folded Devonian rocks consisting mainly of light-gray faintly mottled massive dolomite, with lesser silty, brown-weathering limestone, and light-gray quartzite. A quartz porphyry dike 2 feet thick that strikes generally northwest and dips gently northeast is exposed in the central part of the mine area. This dike is highly altered and consists mainly of quartz, sericite, and calcite, with subordinate iron oxides and pyrite. Quartz appears to be the chief primary mineral both as phenocrysts and in the groundmass. Most of the other primary minerals are completely altered.

The major talc deposits are in four large shear zones that strike about N. 20°-30° W. and dip southwest. The main ore bodies are the West ore body, Central body, East ore body, and Evening Star ore body (Page, 1951, p. 16). Numerous smaller exposures of talc are in the mine area, commonly localized in N. 70°-80° W.-trending steep shear zones.

The West and Central ore bodies accounted for most of the production. The West ore body is 550 feet long on the surface and 5 to 60 feet thick. It thins with depth and about 100 feet below the surface it is manifested by two salientlike prolongations. The Central ore body is 680 feet long on the surface and 70 feet thick. It has been mined for a vertical distance of almost 400 feet below the surface, but its downward extensions are apparently discontinuous along strike.

The East End ore body is 2 to 15 feet thick and developed for more than 180 feet along strike and 100 feet down dip. Workings in the adjacent hills southeast of the East End shaft and access road are probably on the same ore-controlling structure as the East End ore body. The Evening Star ore body is irregularly shaped and crops out for almost 200 feet in length and has a maximum thickness of 50 feet.

Most of the talc deposits are within massive light-gray dolomite. Many are in the proximity of quartzite, and a few are near brown-weathering silty limestone. Characteristically the talc is fine grained and pale greenish gray. In places it is strongly sheared and foliated. Most of the talc is of steatite grade, and some of it is of exceptional purity.

Trinity Mine

The Trinity mine is 4,000 feet west of the Talc City mine in sec. 30 (projected), T. 18 S., R. 40 E. It is owned by the Sierra Talc and Clay Company. Talc was mined mainly from a northwest-trending glory hole 150 feet long, 50 feet wide, and 50 feet deep. Other workings include an inclined shaft about 100 feet deep, several adits, a vertical shaft, and numerous drifts, crosscuts, and stopes. Many of the underground workings are caved and inaccessible.

The country rock is light-gray dolomite of the upper part of the Ely Springs dolomite. Dolomite of the Pogonip group is in fault contact with Ely Springs dolomite in the southern part of the mine area and Eureka quartzite is present locally along this fault. Talc is mainly in a N. 72° W.-trending, gentle southwest-dipping shear zone. The talc is fine-grained, pale green variety of steatite grade.

Victory Mine

The Victory mine is in sec. 19 (projected), T. 18 S., R. 40 E. (pl. 1). The mine is owned by Edith Lockhart and George Koest. The main workings consist of a northeast-trending adit 170 feet long and a shallow shaft. Talc is irregularly distributed in an altered shear zone within Hidden Valley dolomite near the contact with Ely Springs dolomite. The shear zone strikes N. 44° E., dips 60° NW., and has a maximum thickness of 8 feet.

Viking Mine

The Viking mine is in secs. 23 and 24 (projected), T. 18 S., R. 39 E. (pl. 1). The mine is owned by Edith Lockhart, Ida Nelson, and George and Helen Knight. Production was from the Viking number 1 and Viking number 4 claims. The Viking number 1, the easternmost of the claims, is developed by a shaft less than 100 feet deep, two drifts, and minor trenches. Talc is mainly along a N. 33° E.-trending minor shear zone cutting Eureka quartzite and Ely Springs dolomite.

The Viking number 4 claim is on a shear zone striking N. 75° W. and dipping 80° SW. The mine is worked by two shafts and two adits. Ely Springs dolomite is south of the shear zone and Eureka quartzite to the north. The Eureka quartzite forms a wedge-shaped, fault-bounded outcrop.

White Swan Mine

The White Swan mine includes several claims in sec. 23 (projected), T. 18 S., R. 39 E., at the northwest end of the Talc City Hills. The mine is owned by Mrs. Edna M. Towers. Workings, which for descriptive purposes are grouped as the North workings and the South workings, are on many shear zones in the mine area. The North workings include an adit about 100 feet long and a pit about 50 feet long, 30 feet wide, and 20 feet deep, on a N. 83° W.-trending shear zone in Ely Springs dolomite. Talc surrounds fragments of brecciated dolomite within the shear zone. Another shear zone, about 50 feet to the south in Ely Springs dolomite, strikes N. 60° E. and dips 74° SE. The shear zone is 8 feet thick and contains a talc-bearing border zone about 6 inches thick on the footwall. Other smaller workings expose small lenses of talc.

The South workings consist of 2 adits, a shaft, and surface cuts on a N. 80° W.-striking shear zone that dips 80° NE. Dolomite of the Pogonip group is north of the shear zone and dolomite and limestone of the Lost Burro formation are to the south. Talc is irregularly distributed in small pods in the thick shear zone.

Iceland Spar

Coarse calcite crystals are a common accessory mineral in many of the lead-zinc-silver deposits in the quadrangle, but they are generally discolored by iron oxides and other impurities. Only one deposit has been developed for iceland spar. This is the Iceland prospect in sec. 3, T. 19 S., R. 40 E., in the northern part of the Darwin Hills. The property is owned by the estate of W. R. Wallace. Workings consist of an open cut 60 feet long, with small irregular underground workings near its northwest end, a vertical shaft 40 feet deep, and minor surface cuts. Calcite occurs as cavity fillings between coarse limestone fragments in a N. 45° … trending, vertical fault zone. The coarse calcite rhon… hedrons are a maximum of 4 inches across cleav… fragments. The quality of the iceland spar is impai… by imperfect transparency due to iron oxide discol… tion and local fracturing. No production is recor… from the property.

Limestone and Dolomite

The Darwin quadrangle is a large potential sourc… limestone and dolomite, but their development is h… pered by distances from markets. Limestone of … Devonian and younger Paleozoic rocks probably coul… used in the manufacture of cement. The Tin Mount… limestone and the upper part of the Lost Burro for… tion are the most likely sources. Minor shallow drill… was done a few hundred feet north of the Lee Flat r… in the Santa Rosa Hills by operators who contempla… quarrying Tin Mountain limestone for ornamental … building stone, but no limestone was mined.

Massive dolomite in the Devonian and older rock… abundant in the Talc City Hills. The massive light-g… Hidden Valley dolomite probably would be the m… suitable formation for commercial exploitation.

Quartzite

The upper part of the Eureka quartzite is excepti… ally pure and is a potential source of silica for refr… tory silica brick. The Eureka quartzite crops out at … north end of the Talc City Hills at the Hard Scram… mine and north of the White Swan mine.

LITERATURE CITED

Aubury, L. E., 1902, The copper resources of California: C… Min. Bur. Bull. 23, 282 p.

———, 1908, The copper resources of California: Calif. Min. … Bull. 50, 366 p.

Burchard, H. C., 1884, Report of the U. S. Director of the M… upon the statistics of the production of precious metals in … United States for the calendar year 1883.

Butner, D. W., 1949, Investigation of tungsten occurrences … Darwin district, Inyo County, Calif.: U. S. Bur. Mines R… Inv. 4475, 6 p.

Carlisle, Donald, and others, 1954, Base metal and iron depo… of Southern California: Calif. Div. Mines Bull. 170, chap… p. 41-49.

Chalfant, W. A., 1933, The story of Inyo (rev. ed.), Los Ang… Citizens Print Shop, Inc., 430 p.

Crawford, J. J., 1894, Argentiferous galena—Inyo County: C… Min. Bur. Rept. 12 (second biennial), p. 23-25.

———, 1896, Argentiferous galena—Inyo County: Calif. Min. … Rept. 13 (third biennial), p. 32-33.

Davis, D. L., and Peterson, E. C., 1948, Anaconda's operation… Darwin Mines, Inyo County, Calif.: Am. Inst. Mining … Trans., Tech. Pub. 2407, 11 p.

DeGroot, Henry, 1890, Inyo County: Calif. Min. Bur. Rept. … p. 209-218.

Faul, Henry, 1954, Nuclear geology: New York, John Wile… Sons, 414 p.

Gay, T. E., Jr., and Wright, L. A., 1954, Geology of the Talc … area, Inyo County: Calif. Div. Mines Bull. 170, map s… no. 12.

Goodyear, W. A., 1888, Inyo County: Calif. Min. Bur. Rept … p. 224-309.

Hopper, R. H., 1947, Geologic section from the Sierra Nevada … Death Valley, Calif.: Geol. Soc. America Bull., v. 58, no. … 393-432.

Kelley, V. C., 1937, Origin of the Darwin silver-lead depos… Econ. Geology, v. 32, p. 987-1008.

, V. C., 1938, Geology and ore deposits of the Darwin silver-
mining district, Inyo County, Calif.: Calif. Jour. Mines and
logy, v. 34, p. 503-562.
, Adolph, 1914, The Darwin silver-lead mining district, Cali-
ia: U. S. Geol. Survey Bull. 580-A, p. 1-18.
-, 1918, A geological reconnaissance of the Inyo Range and the
ern slope of the Sierra Nevada, Calif., with a section on the
tigraphy of the Inyo Range by Edwin Kirk: U. S. Geol.
vey Prof. Paper 110, 130 p.
vett, E. M., Jr., 1953, Geology of the Santa Rosa lead mine,
County, Calif.: Calif. Div. Mines Special Rept. 34, 9 p.
ster, J. F., 1952, Rocks and structure of the Quartz Spring
, northern Panamint Range, California: Calif. Div. Mines
cial Rept. 25, 38 p.
-, 1955, Geology of mineral deposits in the Ubehebe Peak
adrangle, Inyo County, Calif.: Calif. Div. Mines Special
t. 42, 63 p.
-, 1956, quad. map, GQ-95. Geology of the Ubehebe Peak
drangle, Inyo County, Calif.: U. S. Geol. Survey.
m, C. W., 1954, Rocks of Paleozoic age in southern Cali-
ia: Calif. Div. Mines Bull. 170, chap. 3, p. 9-14.
m, C. W., and Hall, W. E., 1957, Pennsylvanian and Per-
rocks of the southern Inyo Mountains, Calif.: U. S. Geol.
vey Bull. 1061A, p. 1-15.
n, L. A., Jr., and Stewart, R. M., 1951, Mines and mineral
urces of Inyo County: Calif. Jour. Mines and Geology, v. 47,
7-223.

Page, B. M., 1951, Talc deposits of steatite grade, Inyo County, Calif.: Calif. Div. Mines Spec. Rept. 8, 35 p.

Raymond, R. W., 1877, Statistics of mines and mining in the States and Territories west of the Rocky Mountains: Eighth Annual Rept. Washington Printing Office, p. 25-30.

Robinson, L. L., 1877, Annual report to the stockholders of the New Coso Mining Company, San Francisco, 39 p.

Schultz, J. R., 1937, A late Cenozoic vertebrate fauna from the Coso Mountains, Inyo County, Calif.: Carnegie Inst. Washington Pub. 487, p. 75-109.

Tucker, W. B., 1921, Los Angeles district—Inyo County: Calif. Min. Bur. Rept. 17, p. 273-305.

———, 1926, Los Angeles field division—Inyo County: Calif. Min. Bur. Rept. 22, p. 453-530.

Tucker, W. B., and Sampson, R. J., 1938, Mineral resources of Inyo County: Calif. Div. Mines, Rept. 34, p. 368-500.

———, 1941, Recent developments in the tungsten resources of Calif.: Calif. Div. Mines, Rept. 37, p. 565-588.

Waring, C. A., and Huguenin, Emile, 1919, Inyo County: Calif. Min. Bur. Rept. 15, p. 29-134.

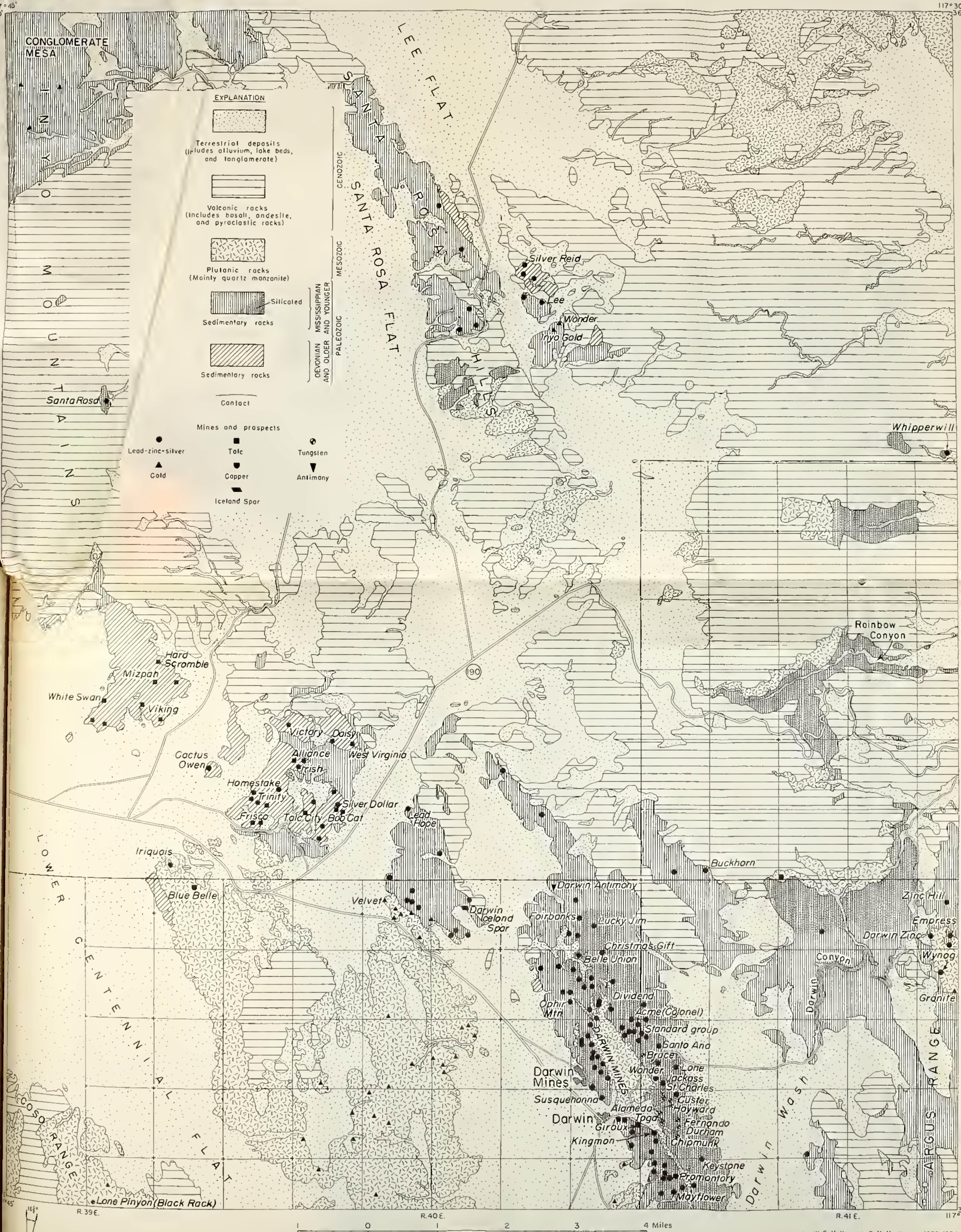
White, W. S., and Jahns, R. H., 1950, Structure of central and east-central Vermont: Jour. Geology, v. 58, p. 179-220.

Wilson, L. K., 1943, Tungsten deposits of the Darwin Hills, Inyo County, Calif.: Econ. Geology, v. 38, p. 543-560.

Anonymous, 1948, Climatological data for the United States by sections (California Section): U. S. Dept. of Commerce, Weather Bur., v. 33, p. 145-156.

printed in CALIFORNIA STATE PRINTING OFFICE

8 5-58 3,500



SIMPLIFIED GEOLOGIC MAP OF THE DARWIN QUADRANGLE SHOWING THE LOCATION OF MINES AND PROSPECTS

DIVISION OF MINES
OLAF P. JENKINS, CHIEF

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Topography modified from Darwin quadrangle, 15 minute, 1951, U.S. Geological Survey

Geology by W. E. Hall and E. M. MacKevett, 1953

0 1 2 MILES

Contour interval 100 feet; datum mean sea level

EXPLANATION

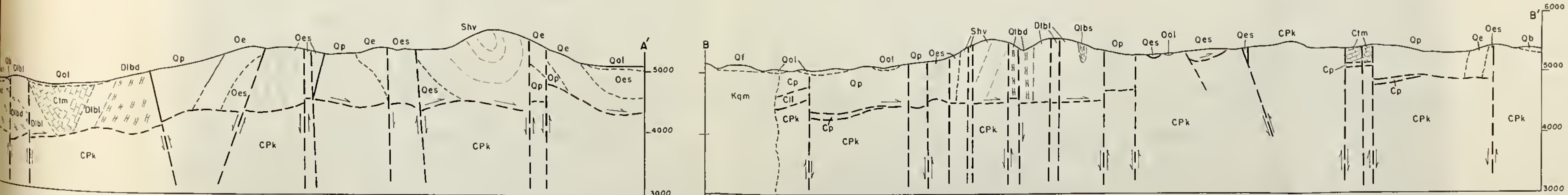
Qal	Alluvium	Recent	QUATERNARY
Qb	Olivine basalt (dike)	Pleistocene	QUATERNARY
Qf	Fanglomerate	Pleistocene	QUATERNARY
Tp	Pyroclastic rocks (Includes tuff-breccia, agglomerate, and basalt cinders)	Pliocene(?)	TERTIARY
Kqm	Quartz monzonite		CRETACEOUS
Pov	Owens Valley formation		PERMIAN
CPk	Keeler Canyon formation		PENNSYLVANIAN
Crs	Rest Spring shale		PENNSYLVANIAN / CARBONIFEROUS
Clf	Lee Flat limestone		MISSISSIPPIAN / CARBONIFEROUS
Cp	Perdido formation (silicated)		MISSISSIPPIAN / CARBONIFEROUS
Ctm	Tin Mountain limestone		MISSISSIPPIAN / CARBONIFEROUS
Dlbs, Dlbl, Dlbd, Dlbq	Lost Burro formation (Shale, Dlbs; limestone, Dlbl; dolomite, Dlbd; quartzite, Dlbq)		DEVONIAN
Shv	Hidden Valley dolomite		SILURIAN
Oes	Ely Springs dolomite		ORDOVICIAN
Oe	Eureka quartzite		ORDOVICIAN
Op	Pogonip group		ORDOVICIAN

Talc

Lead, zinc, silver minerals

Mine

Prospect



EXPLANATION

Contact (Dashed where approximate)

Indefinite contact

Overturned contact, showing dip

Fault, showing dip (Dashed where approximate)

Vertical fault

Thrust fault, showing dip (Saw-teeth on side of upper plate)

(Fault, showing relative movement)

Syncline

Overturned syncline

Inverted anticline, showing plunge

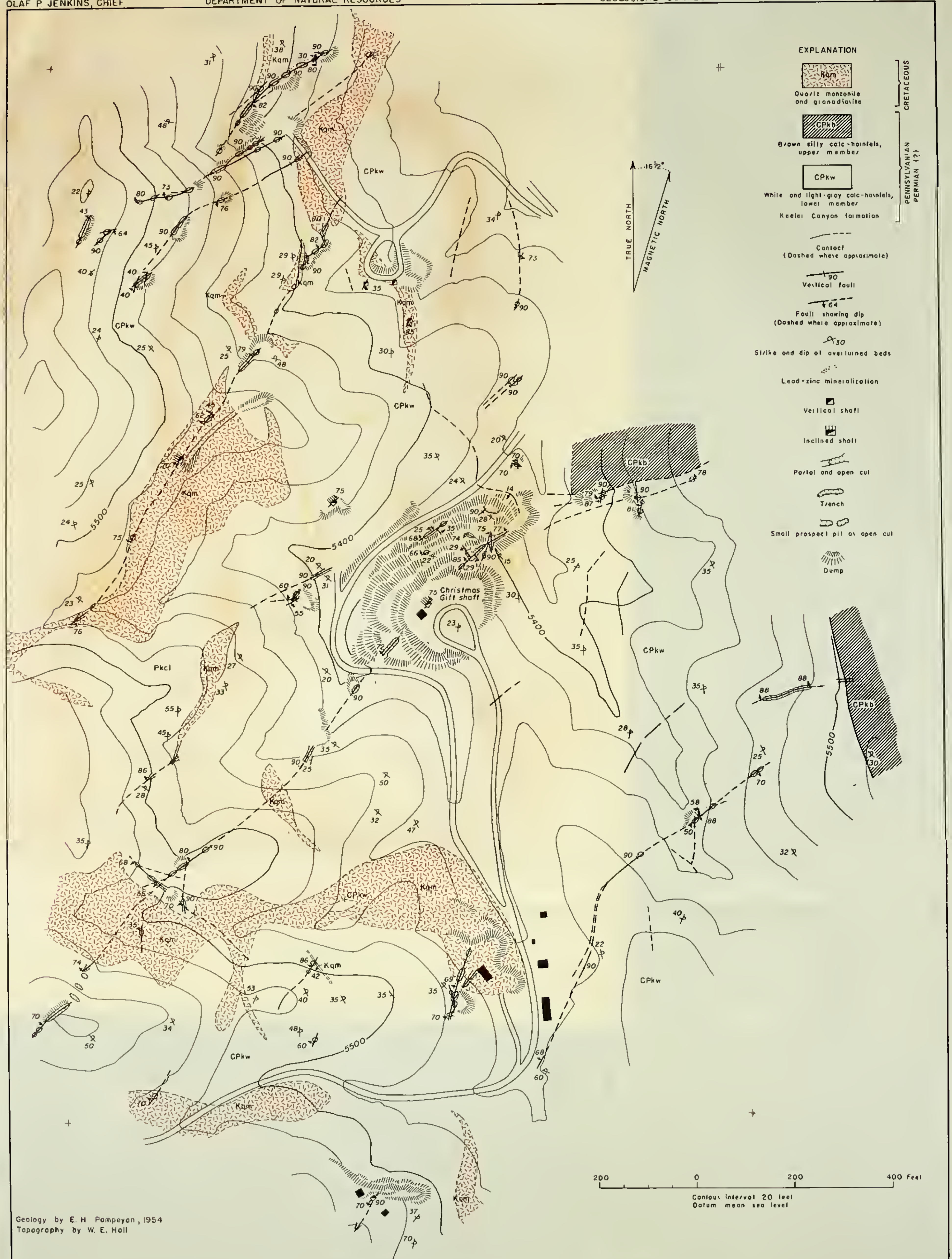
Inverted syncline, showing plunge

Tops known   Tops unknown

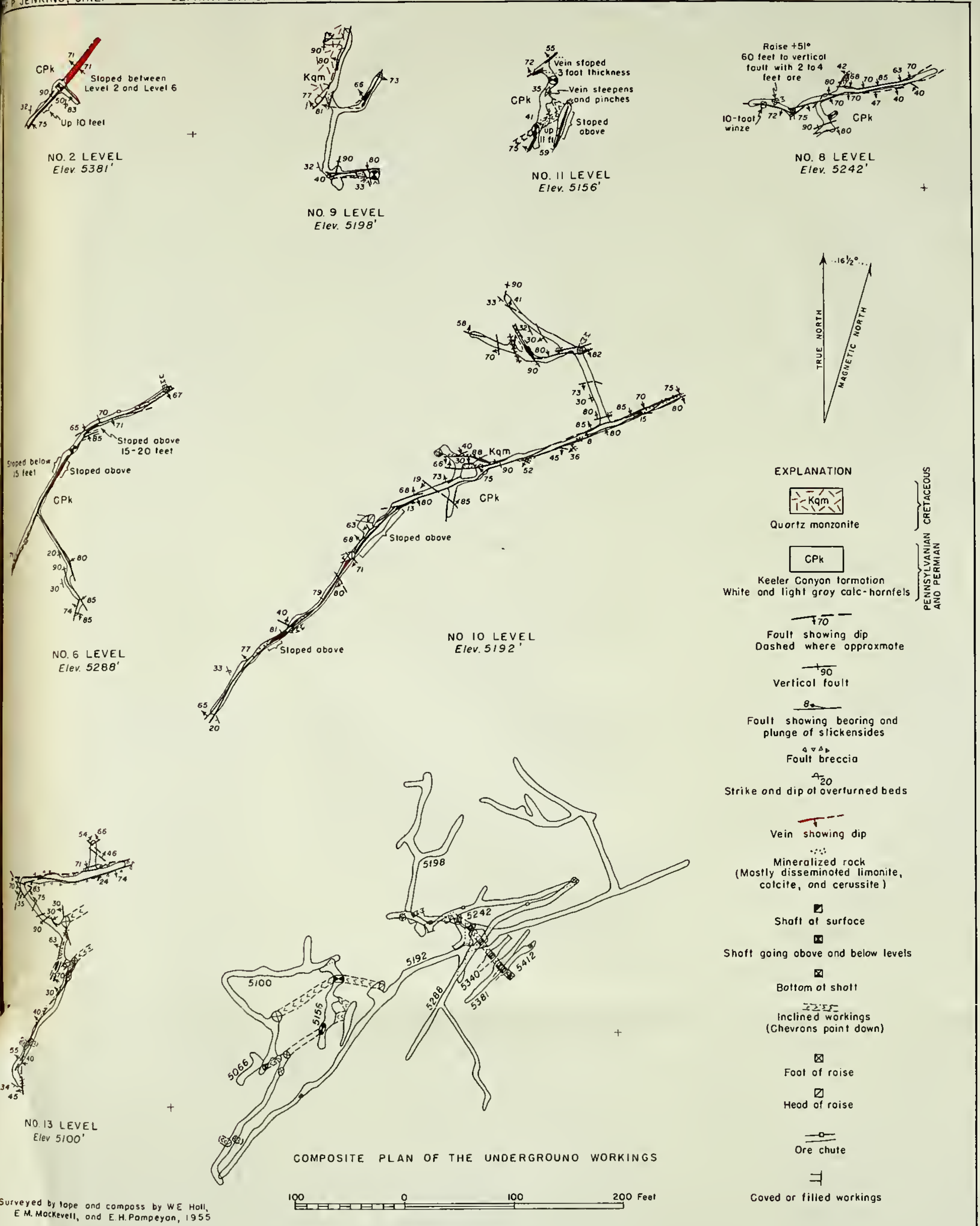
Vertical   Overturned

Attitude of beds

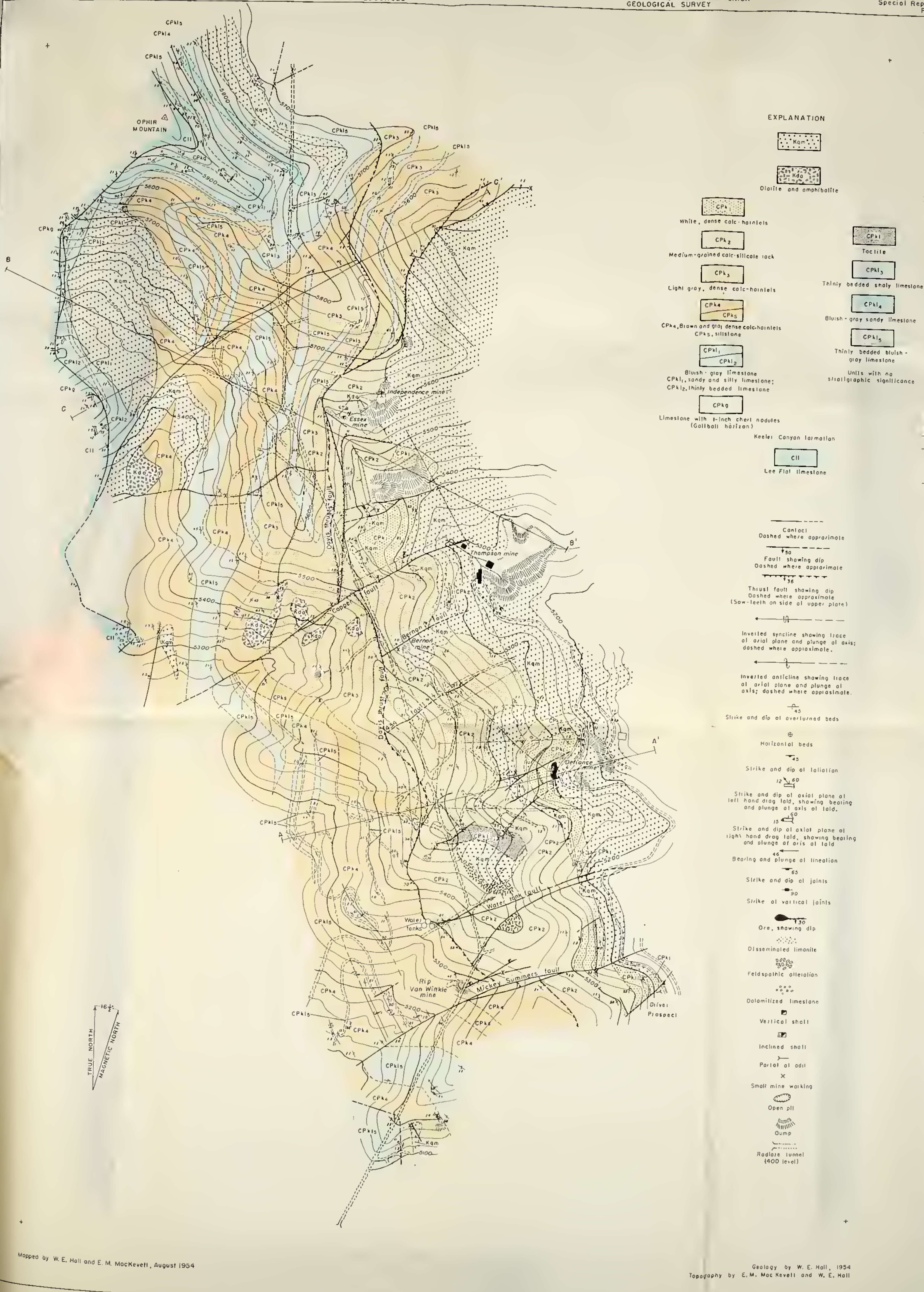
GEOLOGIC MAP AND CROSS SECTIONS OF THE TALC CITY HILLS INYO COUNTY, CALIFORNIA



GEOLOGIC MAP OF CHRISTMAS GIFT MINE AREA



GEOLOGIC MAPS OF THE UNDERGROUND WORKINGS OF THE CHRISTMAS GIFT MINE

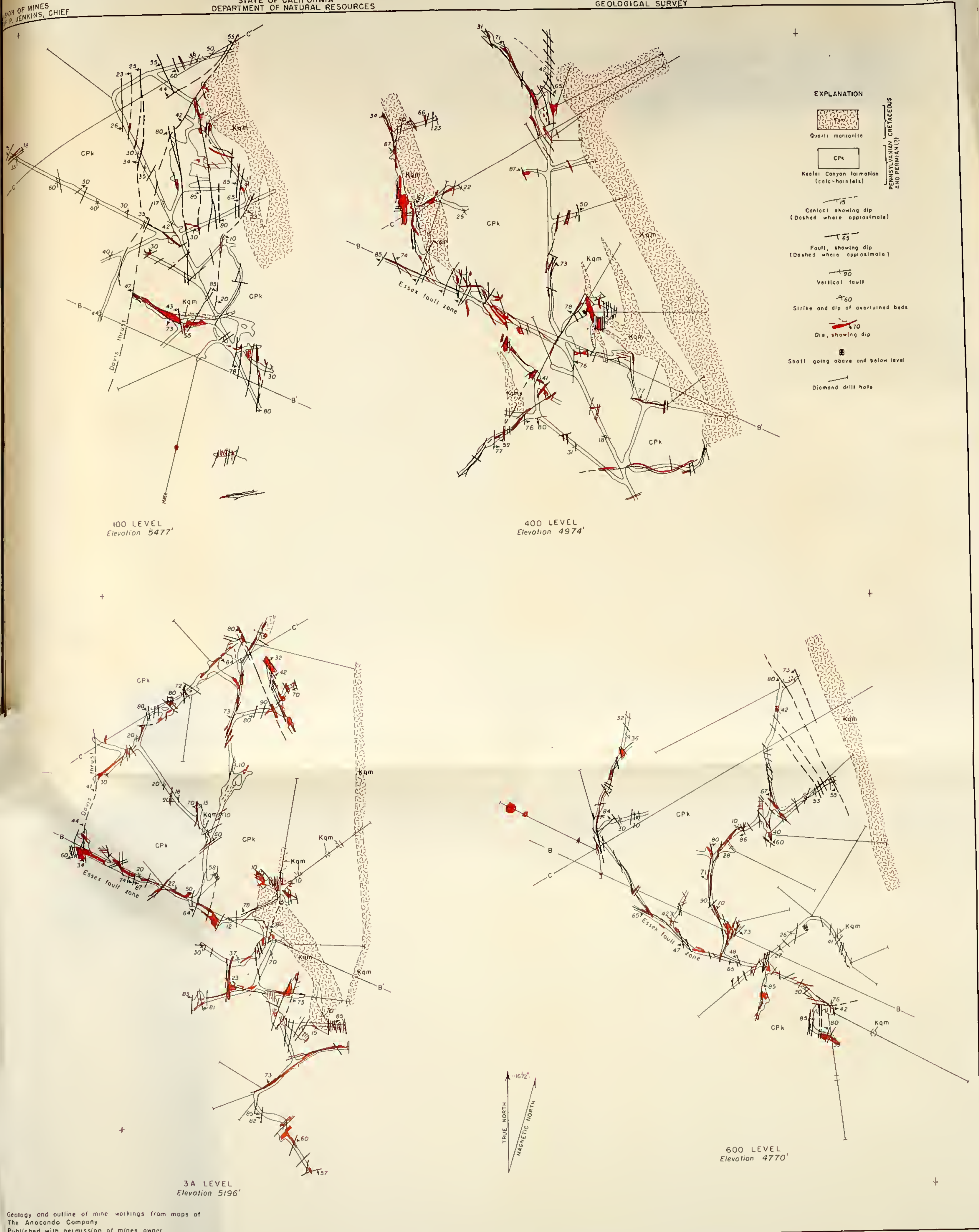


GEOLOGIC MAP OF THE DARWIN MINE AREA, INYO COUNTY, CALIFORNIA

200 0 200 400 600 Feet
Contour interval 25 feet
Datum is mean sea level

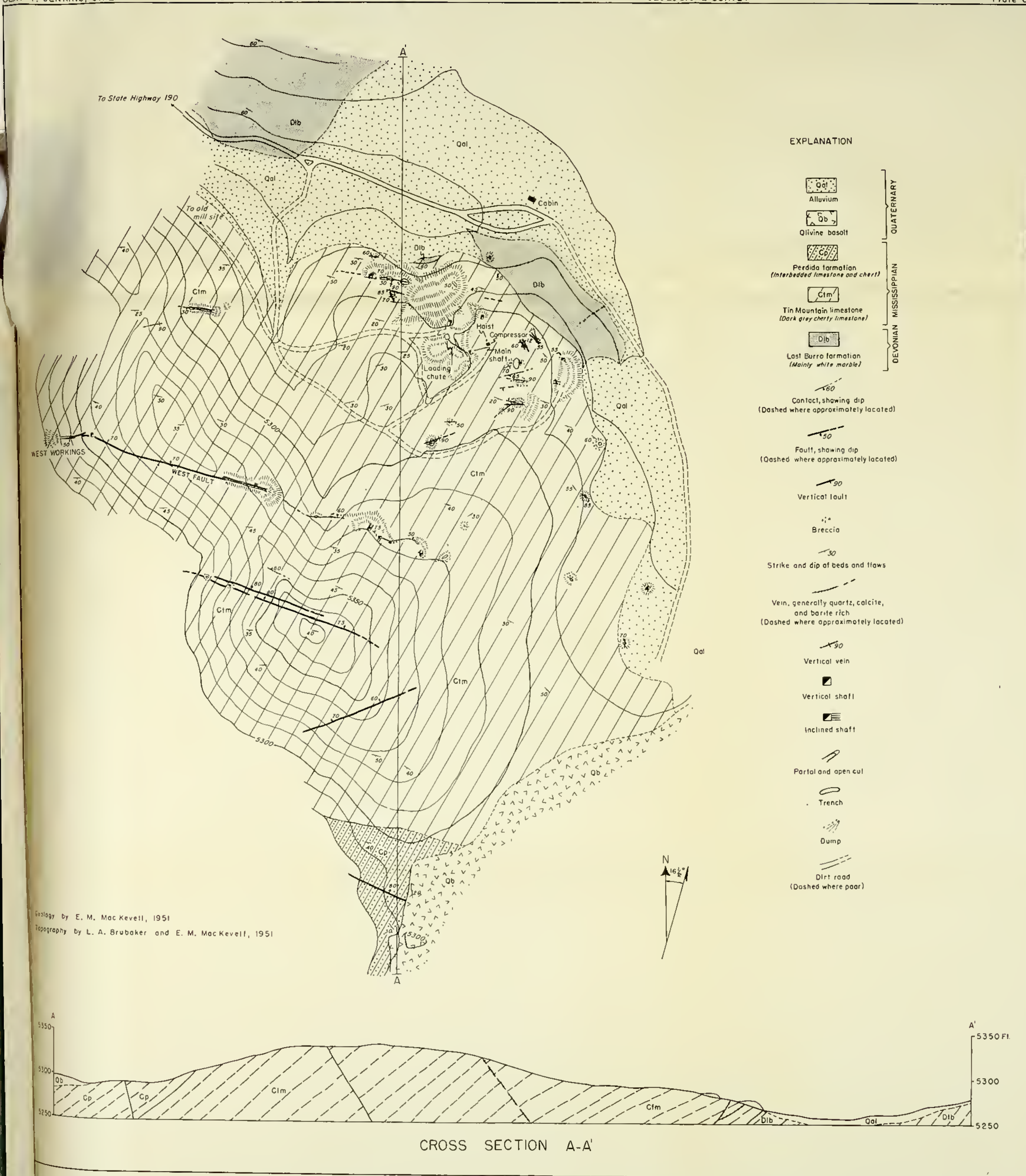
GEOLOGIC MAPS OF THE DEFIANCE WORKINGS OF THE DARWIN MINE, INYO COUNTY, CALIFORNIA

200 0 200 400 Feet



GEOLOGIC MAPS THOMPSON, ESSEX AND INDEPENDENCE WORKINGS OF THE DARWIN MINES

200 0 200 400 feet



GEOLOGIC MAP OF THE LEE MINE AREA

100 0 100 200 Feet

Contour interval 10 feet

GEOLOGIC MAP OF THE DURHAM, FERNANDO AND ST. CHARLES MINES AREA, INYO COUNTY, CALIFORNIA